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Nivelkomponentti ja mekaaninen järjestelmä, joka käsittää tällaisen komponentin

Ledad komponent och mekaniskt system som innefattar en sådan komponent

ARTICULATED COMPONENT AND MECHANICAL SYSTEM COMPRISING SUCH A COMPONENT

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TECHNICAL FIELD

The present invention relates to a hinged component, comprising at least two concentric rings movable with respect to one another and defining a friction interface therebetween. The invention also relates to an mechanical system comprising such a component.

The field of the invention is that of guiding members ensuring a guiding function in translation or in rotation, in continuous or reciprocating movement.

Prior art

Conventionally, such a guiding member is constituted by a ring, designed for the mounting with the ability to articulate and/or to slide an element such as an axle or a shaft.

In practice, such mechanical systems are subjected to high stresses in service: high pressure, corrosion, abrasion, impacts. To improve their service life, a lubrication is provided between the ring and the axle.

The ring can be provided with arrangements acting as a grease reserve, as described, for example, in documents EP 0987456, WO 2014091123 and WO 2014091124 in the name of the Applicant, or in document US 2016/032561 A lubricated guide member comprising multiple sliding rings is further disclosed in document FR 1 418 886 according to the preamble of claim 1.

When the mechanical system is in use, the grease gradually leaves the arrangements to lubricate the friction interface between the ring and the axle. Thus, the arrangements make it optional to carry out lubrication only during assembly, or else with very large lubrication time intervals.

The Applicant has a great deal of expertise in the field of guiding members, and continuously seeks to improve existing systems.

Summary of the invention

The aim of the present invention is to propose an improved hinged component, having in particular excellent resistance to wear and to jamming, and an improved service life.

To this end, the invention relates to a hinged component with one degree of freedom, comprising three concentric rings, rotatable with respect to one another about a central axis, defining friction interfaces therebetween, and including: an outer ring having an inner friction surface, an inner ring having an outer friction surface and an inner friction surface provided to receive a movable element guided by the component in rotation, oscillation and/or translation, and an intermediate ring located between the outer and inner rings. The component according to the invention has five friction surfaces, forming five wear surfaces. A first friction interface is defined between the intermediate ring and the outer ring, a second friction interface is defined between the intermediate ring and the inner ring, the friction interfaces between the rings receiving a lubricant, and at least one of the friction surfaces comprising arrangements capable of acting as a reserve of lubricant. The component according to the invention comprises sealing means on opposite sides of the component arranged to prevent leaks of lubricant out of the friction interface.

Thus, the invention allows to propose a component that is resistant, compact and simple to implement. The component has an improved service life, in comparison with a component which consists of a single ring, and which has similar dimensions and volume.

By way of example, a component having three friction surfaces forms three wear surfaces. With respect to a component consisting of a single ring with a single internal friction surface, the service life of the component with three friction

surfaces should be multiplied by three. Surprisingly, the experiments showed that its service life was multiplied by at least five.

In the case of a single articulation ring, the wear is generally localized over an angular sector extending over 1/3 of the circumference. According to the invention, the inner ring rotates relative to the outer ring, which greatly increases the potential wear surface, and therefore the service life of the component.

In practice, it can be seen that the friction interface between the two rings takes priority. The facing friction surfaces perform the function of main wear surfaces. When this interface is seized, the inner friction surface of the inner ring takes over as the wear surface.

Advantageously, the component has five friction surfaces that may be provided with a surface treatment or coating and/or arrangements capable of acting as a reserve of lubricant. Thus, the invention offers greater control in the design of the component, making it possible to adapt its wear resistance to each application.

According to other advantageous characteristics of the invention, taken individually or in combination:

- The friction surfaces delimiting the friction interface are cylindrical.
- The friction surfaces delimiting the friction interface are slightly curved. The absolute radius of curvature of each friction surface is strictly greater than the radius of the friction interface under consideration.
- The lubricant is grease.
- The component comprises lateral elements limiting the axial and angular movement of the inner ring relative to the outer ring.

- The sealing means comprise a flange on a first side of the friction interface, and a shoulder on a second side of the friction interface.
- The sealing means comprise a flange on each side of the friction interface.
- The sealing means comprise a washer interposed between the inner ring on the one hand, and the flange or the shoulder on the other hand, on each side of the friction interface.
- The washer is in PTFE.
- At least one of the friction surfaces comprises a surface treatment or coating having physical properties different from the base material of the ring.
- The surface treatment or coating is multilayer or single-layer.
- The coating is produced by physical vapour deposition (PVD).
- The coating is produced by chemical vapour deposition (CVD).
- The coating is produced by hot spraying.
- The coating is produced by cold spraying.
- The coating is produced in powder form.
- The coating is produced in the form of drops.
- The coating is produced by means of thermal spraying a high velocity oxy fuel (HVOF).
- The coating is produced by means of laser cladding.
- The coating is anti-seizing.
- The coating comprises an outer layer of amorphous carbon of the DLC (diamond-like carbon) type, in particular with a thickness of between 1 to 5μm, for example 3μm.
- The coating comprises an outer layer of self-lubricating composite, in particular resin- and/or woven or non-woven reinforcing, comprising, for example, PTFE, MoS2 or graphite type fillers.
- The coating comprises a polymer varnish.

- The treatment is a nitriding, and the friction surface have a combination layer (white layer) having a thickness in particular of between 5 and 50μm, for example 20μm.
- The treatment is a cementation on a thickness of between 0.5 and 4mm, for example 2mm.
- The arrangements include cavities of circular or alveolar section.
- The cavities are macro-cavities, each having a diameter of between 2 and 15mm, for example 6mm.
- The cavities are microcavities, each having a greater length of between 15 and 100μm, and a depth of between 50 nm and 100 μm.
- The arrangements comprise circular or helical grooves.
- The arrangements comprise a grid.
- The arrangements comprise chevrons.
- The same surface may comprise arrangements of several different types, or of only one type only.
- The arrangements have a surface density of between 5 and 65%, this surface density being defined as the ratio of the total area covered by the arrangements to the total area of the said zone including these arrangements.
- Each friction surface comprises a surface treatment or coating having physical properties different from the base material of the ring and/or arrangements capable of acting as a reserve of lubricant.
- At least one of the friction surfaces comprises simultaneously a surface treatment or coating having physical properties different from the base material of the ring, and arrangements capable of acting as a reserve of lubricant.
- The outer ring and/or the inner ring is metallic, e.g. in steel, cast iron, aluminium, copper alloy, etc.
- The outer ring and/or the inner ring is of a composite material.

- The intermediate ring is self-lubricating. More specifically, the outer friction surface and/or the inner friction surface of the intermediate ring is self-lubricating.
- The intermediate ring comprises a winding of fabric strips and a resin comprising fillers, mixed in such a way to implement a homogeneous product, the strips being crossed over several layers by means of filament winding.
- The intermediate ring is metallic.
- The intermediate ring is of a composite material.
- The hinged component includes four or more rings.

The invention also related to a mechanical system, comprising a hinged component such as mentioned above, and a movable element guided by the component in rotation, oscillation and/or translation.

The mechanical system comprises six friction surfaces, namely the outer surface of the axle, and the five surfaces of the hinged component. The service life of the mechanical system is greatly improved, with respect to an axle mounted in a ring.

BRIEF DESCRIPTION OF THE DRAWINGS

The invention will be better understood from the following description which is given solely by way of non-limiting example and is made with reference to the appended drawings, wherein:

- Figure 1 is an exploded perspective view of a mechanical system not in accordance with the invention, comprising an axle and a hinged component consisting of two rings and sealing means;
- Figure 2 is a side view of the component of Figure 1.
- Figure 3 is a perspective view of the component of Figure 1;
- Figure 4 is a section along the line IV-IV in Figure 2;

- Figure 5 is a larger scale view of detail V in Figure 4;
- Figure 6 is an exploded perspective view of another mechanical system, comprising an axle and a variant of a hinged component; Figures 7 to 10 are views similar to Figures 2 to 5, for the component of Figure 6;
- Figures 11 and 12 are views similar to Figures 4 and 5, for a component according to the invention, comprising three rings delimiting two friction interfaces between them; and
- Figures 13 and 14 are views similar to Figures 4 and 5, for another variant of the component not according to the invention, comprising three rings delimiting a single friction interface therebetween.

Figures 11 and 12 show a component according to the invention. The other figures are not in accordance with the invention as claimed but make it possible to understand the context of the invention.

DETAILED DESCRIPTION OF THE INVENTION

Figures 1 and 5 show a mechanical system, comprises a hinged component 1 also in accordance with the invention, and an axle 2 mounted within the compound 1 10. The axle 2 is guided by the hinged component 1 in rotation (pivoting in a one direction, usually over several revolutions), oscillation (pivoting in two alternate directions, generally over a portion of a turn) and/or translation (movement in the axial direction).

The hinged component 1 comprises two concentric rings 10 and 20, movable with respect to one another in rotation about a central axis X1. The two rings 10 and 20 define therebetween a friction interface 40 receiving a lubricant L, preferably grease.

The two rings 10 and 20 include an outer ring 10 and an inner ring 20. The outer ring 10 has a cylindrical inner friction surface 12, and a cylindrical outer

bearing surface 14. The inner ring 20 has a cylindrical outer friction surface 22, and a cylindrical inner friction surface 24.

The surfaces 12 and 22 define the friction interface 40 therebetween, radially to the central axis X1. The surface 14 is provided for the mounting the outer ring 10 within a borehole. A channel 42 is arranged radially through the ring 10 between the surfaces 12 and 14, in order to lubricate the interface 40. The surface 24 is provided for receiving the axle 2, more precisely the cylindrical outer surface 4 of the axle 2. Thus, the axle 2 is guided by the component 1 in rotation, oscillation and/or translation.

The component 1 comprises sealing means on 60 designed to prevent leaks of lubricant L from the friction interface 40. The component 1 thus constitutes a sealed lubricated structure. The relative rotation between the rings 10 and 20 is therefore greatly facilitated, and the risk of seizing is reduced.

The sealing means 60 comprise lateral elements 62, 64, 66 and 68 limiting the axial movement of the inner ring 20 in relation to the outer ring 10. More specifically, the sealing means 60 comprise a flange 62 and a washer 66 on a first side of the interface 40, and a shoulder 64 and a washer 68 on a second side of the friction interface 40. The elements 62, 64, 66 and 68 are annular and centred on the axis X1. The shoulder 64 is part of the ring 10. The elements 62, 66 and 68 are separate from the rings 10 and 20. The washer 68 is mounted within a groove 67 formed within the ring 10, against the shoulder 64. The elements 62 and 66 are mounted within a housing 61 provided for this purpose within the ring 10, opposite to the shoulder 64.

Alternatively, the sealing means 60 may comprise two removable flanges assembled on opposite sides of the component 1.

The component 1 is non-jointed, in other words it does not constitute a spherical joint. The assembled component 1 has a single degree of freedom, namely the pivotal connection between the rings 10 and 20 around the central axis

X1. The rings 10 and 20 are freely movable in rotation with respect to one another around the axis X1, but are not freely movable according to the other degrees of freedom, in translation and rotation.

The friction surfaces 12 and 22 may be cylindrical.

Alternatively, the surfaces 12 and 22 may be slightly curved. In other words, the surfaces 12 and 22 are surfaces of revolution, with circular section and elliptical or parabolic generatrix. The curvature of each surface 12 and 22 (considered within a radial plane including the axis X1) has a radius that is greater than the radius (considered within a plane transverse to the axis X1) of the friction interface 40.

Preferably, at least one of the friction surfaces 12/ 22/ 24 comprises a surface treatment or coating having physical properties different from the base material of the corresponding ring 10 / 20.

More preferably, at least one of the friction surfaces 12/ 22/ 24 comprises arrangements capable of acting as a reserve of lubricant L.

Still preferably, each friction surface 12/ 22/ 24 comprises a surface treatment or coating having physical properties different from the base material of the ring 10/ 20; and/or arrangements capable of acting as a reserve of lubricant L.

By way of a non-limiting example:

- the rings 10 and 20 are made of steel;
- -the surface 12 is subject to a a nitriding treatment and has an outer layer 16 of nitrided steel, with a compound layer (white layer) having a thickness of around 20μm;
- the surface 12 includes arrangements 18 in the form of circular section cavities, uniformly distributed around the central axis X1, capable of acting as a reserve of lubricant L at the interface 40 between the rings 10 and 20;

- the surface 22 is coated with an outer layer 26 of DLC type amorphous carbon, having a thickness of the order of 3μm, with or without a sub-layer (composed, for example, of chromium or chromium nitride); and
- the surface 24 includes arrangements 28 in the form of circular grooves, wound around the central axis X1 and regularly spaced along the central axis X1, capable of acting as a reserve of lubricant L at the interface between the ring 20 and the axle 2.

The hinged component 1 is resistant, compact and simple to implement. The component 1 comprising two rings 10 and 20 has an improved service life, as compared to a component which is composed of a single ring, and having similar dimensions and volume.

In the case of a single articulating ring, the wear is generally localized over an angular sector extending over 1/3 of the circumference. In this example, the inner ring 10 rotates in relation to the outer ring 20, which greatly increases the potential wear surface, and therefore the service life of the component.

In practice, it can be seen that the friction interface 40 between the two rings 10 and 20 takes priority. The opposing friction surfaces 12 and 22 perform the function of main wear surfaces. When this interface 40 is seized, the inner friction surface 24 of the inner ring 20 in contact with the surface 4 of the axle 2 takes over as the wear surface.

The component 1 has three friction surfaces 12, 22 and 24 forming three wear surfaces, which may be provided with treatment, coating and/or arrangements. Thus, greater control in the design of the component make it possible to adapt its wear resistance to each application.

The mechanical system comprises four friction surfaces 2, namely the outer surface 4 of the axle 2, and the surfaces (12, 22 and 24 of the component 1. The service life of the mechanical system is greatly improved, with respect to an axle assembled in a single ring.

Other variants of hinged components 1 are shown in figures 6 to 14. Some elements that form part of the component 1 are comparable to those of the first embodiment described above and bears the same numerical references for the purposes of simplification.

Figures 6 to 10 show another mechanical system, comprising a variant of component 1 and an axle 2 mounted within the component 1. The friction surfaces 12 / 22 / 24 are devoid of surface treatment or coating, and of arrangements capable of acting as a reserve of lubricant L. The sealing means 60 comprise a flange 62 and a shoulder 64, on the opposite sides of the interface 40. Thus, the component 1 is simpler and less expensive to manufacture than in the first embodiment. Notwithstanding the absence of treatment, coating or arrangements, the component 1 comprising two rings 10 and 20 has an improved service life, as compared to a component which consists of a single ring, and having similar dimensions and volume.

Figures 11 and 12 show a hinged component 1 according to the invention, comprising three concentric rings 10, 20 and 30, movable with respect to one another. The ring 30 is located between the rings 10 and 20. A first friction interface 40 is defined between the rings 10 and 30. A second friction interface 50 is defined between the rings 20 and 30. The component 1 has five friction surfaces 12, 22, 12, 24, 32 and 34 forming five wear surfaces, which may be provided with treatment, coating and/or arrangements.

Figures 13 and 14 show a variant of the hinged component not in accordance with the invention, comprising three concentric rings 10, 20 and 30. The ring 30 is located between the rings 10 and 20. The rings 20 and 30 are movable with respect to one another, and define a friction interface 50 therebetween. The ring 30 is fixed to the ring 10, for example by bonding. The ring 30 can constitute a winding

of fabric strips and a resin comprising fillers, mixed in such a way to implement a homogeneous ring, the strips being crossed overs several layers by filament winding. The component 1 has three friction surfaces 22, 24 and 32 forming three wear surfaces, which may be provided with treatment, coating and/or arrangements.

Moreover, the hinged component 1 can be shaped differently from figures 1 to 14. Furthermore, the technical characteristics of the various variants mentioned above can be combined in their entirety or only in part. Thus, the compound 1 can be adapted in terms of cost, functions and performance.

Tables 1 to 5 below present a series of tests, making it possible to compare two reference rings (single ring receiving an axle) and different embodiments of the invention.

Table 1 — Test parameters and conditions

Bench	Large Oscillation Test Bench
Law of Motion	Sinusoidal oscillation axis
Oscillation amplitude	100°
Projected pressure	90MPa
Average V over one oscillation	0.0079m/s
Average PV	(MPa.m/s)
Grease (type)	Extreme Pressure Grease
Lubrication	Initial Only
Ring material	Steel
Axle material	16NC16 Case hardened Steel
Stoppage criterion	COF > 0.35
	T° > 120°C
	Wear > 0.5mm

Table 2 — Pressure build-up at the start of a test

Pressure	10MPa	30MPa	60MPa	80MPa	90MPa
Number of cycles	100	100	100	200	500,000

Table 3 — Improvements provided on the friction surfaces of the rings

Description	Improvement characteristics
AM 1	The inner friction surface has arrangements, in the form of circular section cavities regularly distributed around the central axis, acting as a reserve of lubricant.
AM2	The internal friction surface receive a nitriding treatment and have a compound layer (white layer) having a thickness of around 20µm.
AM3	The inner friction surface comprises a polymer lacquer coating.
AM4	The external friction surface is coated with an outer layer of DLC type amorphous carbon, having a thickness of around 3µm.
AM5	The inner friction surface comprises arrangements in the form of circular grooves, wound around the central axis and regularly spaced along the central axis, acting as a reserve of lubricant.
Ring 30	An intermediate ring 30 made of self-lubricating composite is bonded to the inner surface of the outer ring 10.

Table 4 — Test results — Single rings

Reference	AM1	AM2	AM3	Number of cycles performed
B1	No	No	No	1,500
B2	Yes	Yes	Yes	125,000

Table 5 — Test results — Components complying with the invention

	Outer ring 10 Inner surface 12			Ring 20		Intermediate ring 30	
Reference component 1	AM1	AM2	AM3	AM4 Surface 22	AM5 surface 24		Number of cycles done
C-BH1	No	No	No	No	No	No	7,000
C-BH2	Yes	Yes	Yes	No	No	No	350,000
C-BH3	Yes	Yes	Yes	Yes	No	No	410,000
C-BH4	Yes	Yes	Yes	Yes	Yes	No	530,000
C-BH5	Yes	Yes	No	Yes	Yes	Yes	> 500,000

The results of the series of tests make it possible to make the following observations:

- The C-BH1 component completed a number of cycles equivalent to 4.6 times that of the B1 ring.
- The C-BH2 component completed a number of cycles equivalent to 3.6 times that of the B2 ring.
- The C-BH3 component completed a number of cycles equivalent to 4 times that of the B2 ring.
- The C-BH4 component completed a number of cycles equivalent to 4.6 times that of the B2 ring.
- The test conducted for the C-BH5 component was voluntarily stopped at 500 000 cycles. The service life thereof is much higher than that of the B2 ring.

Thus, the invention makes it possible to provide a hinged component 1 resistant, compact and simple to implement. The component 1 comprising two rings has an improved service life, with respect to a component which consists of a single ring, and having similar dimensions and volume.

PATENTTIVAATIMUKSET

1. Saranoitu komponentti (1), jolla on yksi vapausaste ja joka käsittää kolme samankeskistä rengasta (10, 20, 30), jotka pyörivät toistensa suhteen keskiakselin (X1) ympäri ja muodostavat kitkapinnan (40, 50) niiden välille, ja mukaan lukien:
- ulompi rengas (10), jossa on sisäkitkapinta (12),
- sisärengas (20), jossa on ulompi kitkapinta (22) ja sisäkitkapinta (24), joka on järjestetty vastaanottamaan liikkuva elementti (2), jota komponentti (1) ohjaa pyörimässä, värähtelemässä ja/tai siirtymässä, ja
- välirenkaan (30), joka sijaitsee ulko- ja sisärenkaiden välissä;
ensimmäinen kitkarajapinta (40) on määritetty välirenkaan ja ulkorenkaan välille, toinen kitkarajapinta (50) on määritetty välirenkaan ja sisärenkaan väliin, jolloin komponentissa on viisi kitkapintaa (12; 22; 24; 32) 34),
kitkarajapinnat (40, 50) renkaiden (10, 20, 30) välillä, jotka vastaanottavat voiteluainetta (L) ja vähintään yhtä kitkapinnat (12; 22; 12; 22; 24) käsittävät järjestelyt (18; 28), jotka pystyvät toimimaan voiteluaineen (L) reservinä;
tunnettu siitä, että
komponentti (1) käsittää komponentin vastakkaisilla puolilla tiivistysvälineet (60), jotka on järjestetty estämään voiteluaineen (L) vuodot kitkapinnasta (40).

2. Jonkin edellisen patenttivaatimuksen mukainen saranoitu komponentti (1), **tunnettu siitä, että** se käsittää sivuttaiselementit (62, 64, 66, 68), jotka rajoittavat sisärenkaan (20) aksiaalista ja kulmaliikettä ulkorenkaaseen (10) nähden.

3. Jonkin edellisen patenttivaatimuksen mukainen saranoitu komponentti (1), **tunnettu siitä, että** ainakin yksi kitkapinnoista (12; 22; 24) käsittää pintakäsittelyn tai pinnoitteen (16; 26), jonka fysikaaliset ominaisuudet poikkeavat perusmateriaalista renkaasta (10; 20; 30).

4. Jonkin edellisen patenttivaatimuksen mukainen saranoitu komponentti (1), **tunnettu siitä, että** jokainen kitkapinta (12; 22; 24) käsittää pintakäsittelyn tai pinnoitteen (16; 26), jonka fysikaaliset ominaisuudet poikkeavat renkaan

perusmateriaalista (10; 20; 30) ja/tai järjestelyt (18; 28), jotka pystyvät toimimaan voiteluaineen (L) varavarana.

5. Jonkin edellisen patenttivaatimuksen mukainen saranoitu komponentti (1), **tunnettu siitä, että** ulkorengas (10) ja sisärengas (20) ovat metallia.

6. Mekaaninen järjestelmä, joka käsittää jonkin edellisen patenttivaatimuksen mukaisen saranoidun komponentin (1) ja liikkuvan elementin (2), jota komponentti (1) ohjaa pyörimässä, värähtelemässä ja/tai siirtymässä.

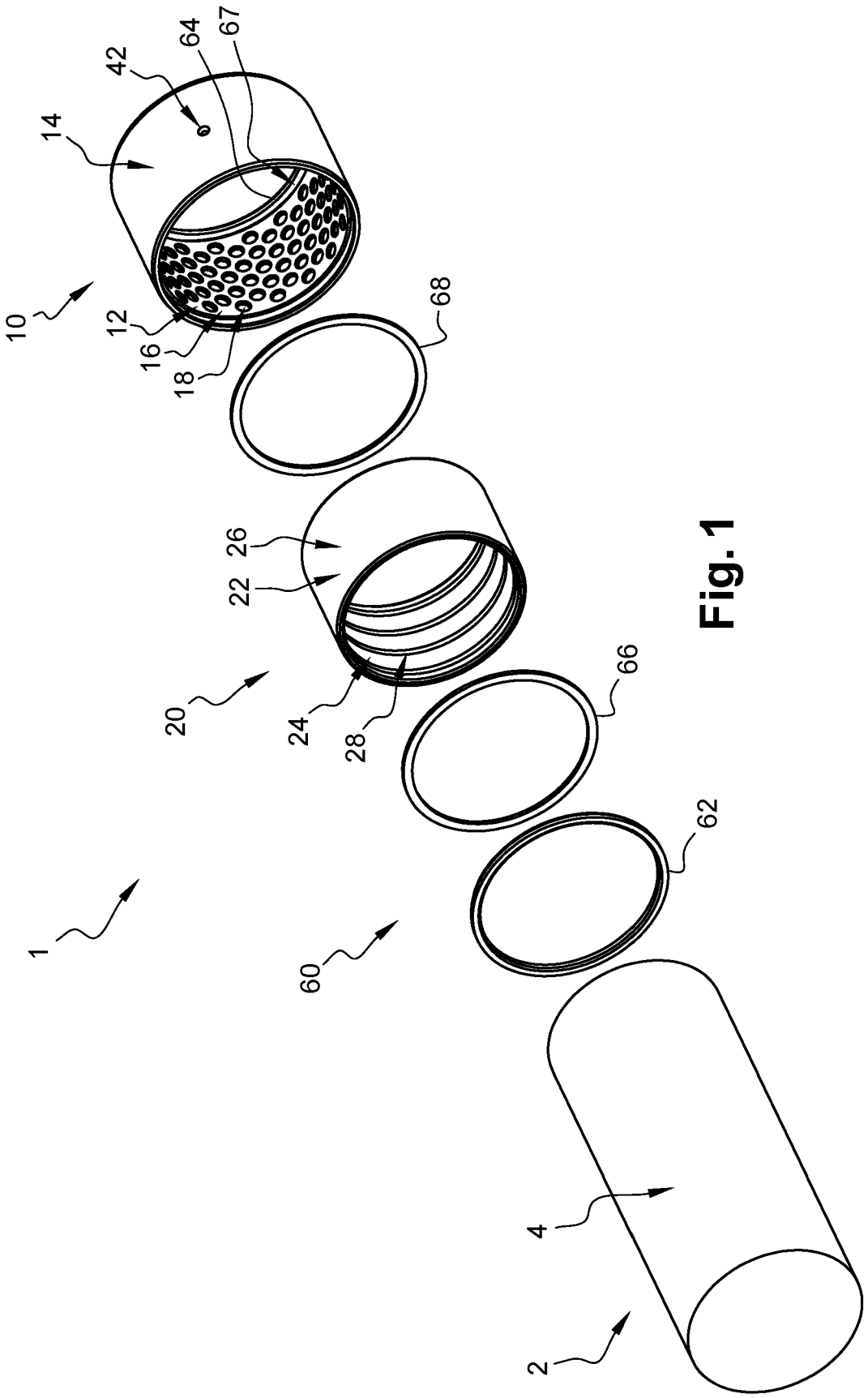


Fig. 1

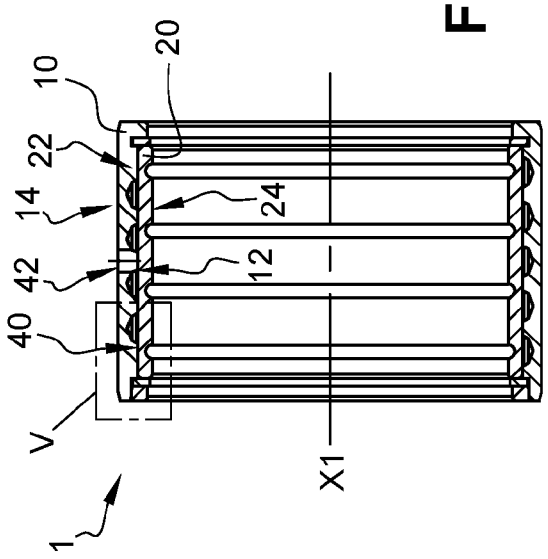


Fig. 4

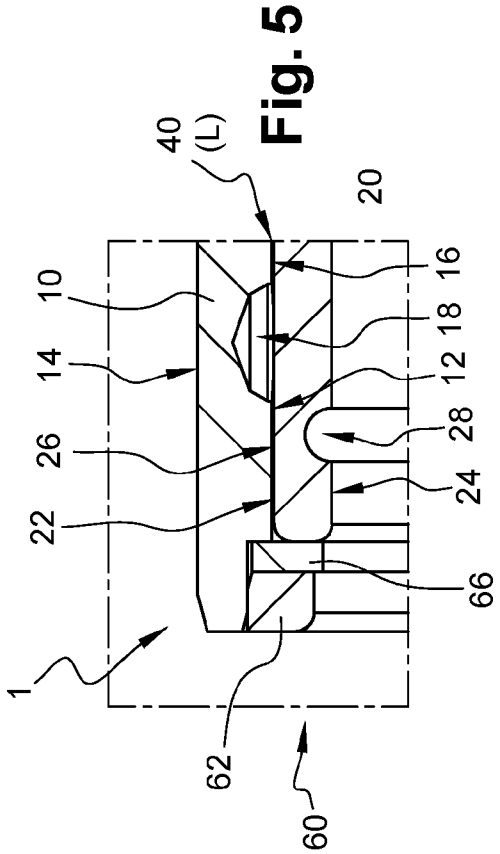


Fig. 5

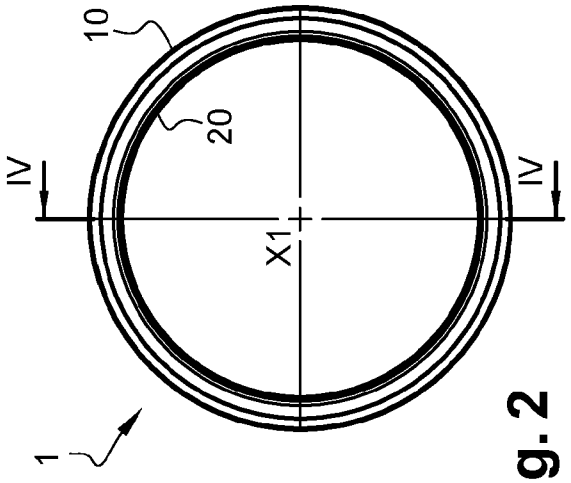


Fig. 2

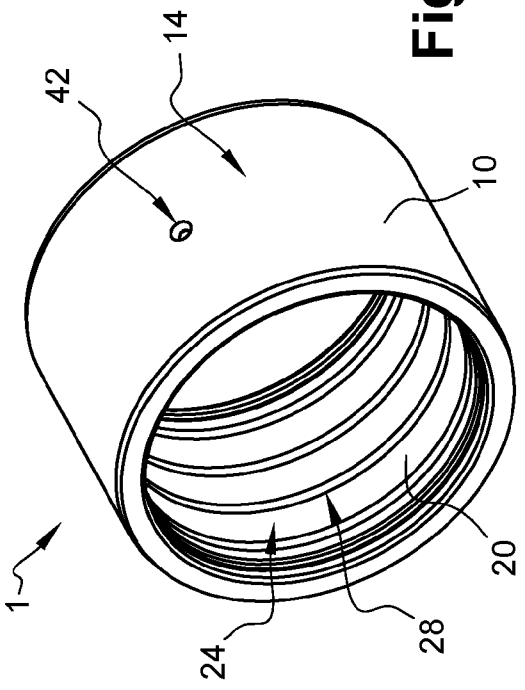


Fig. 3

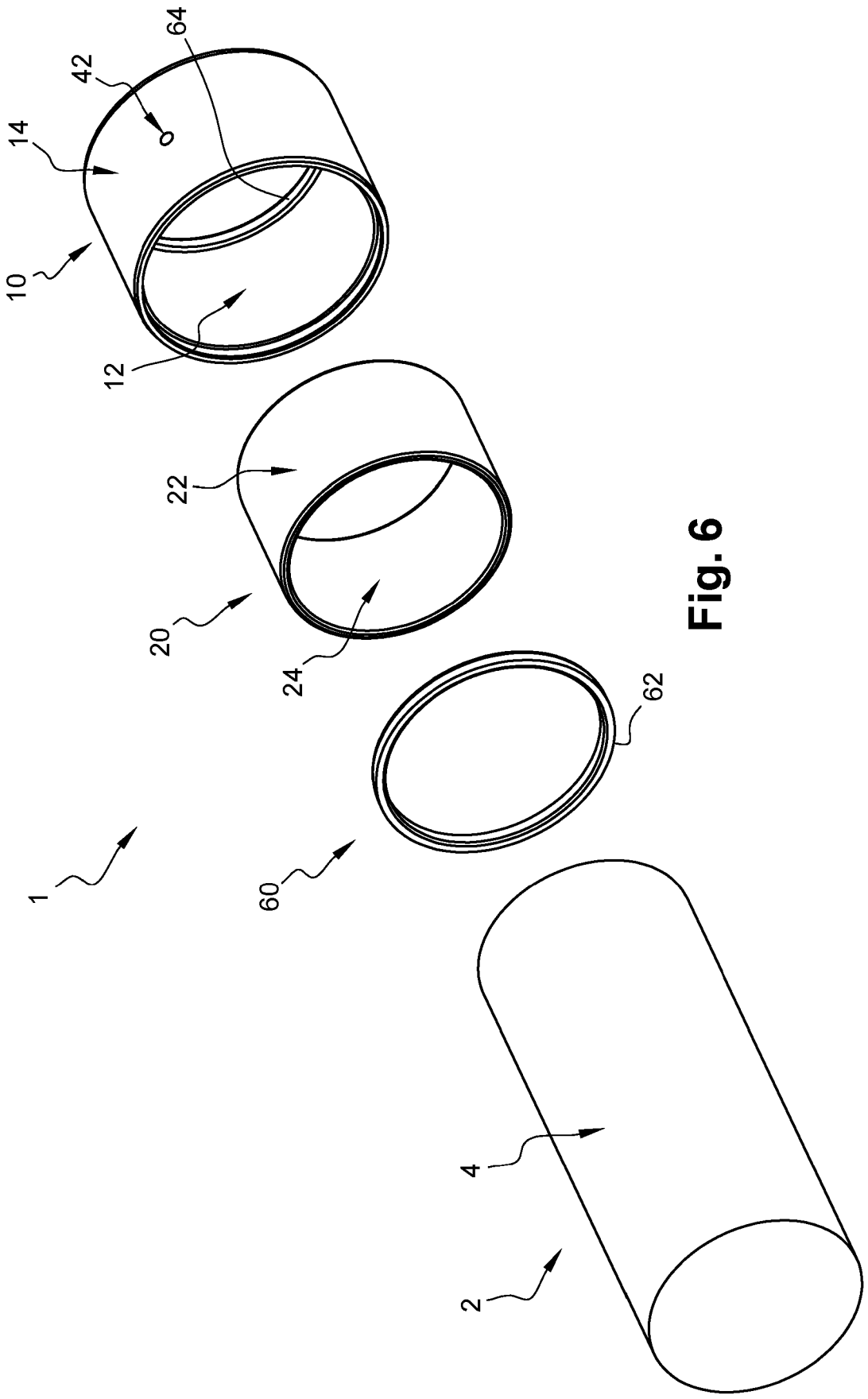


Fig. 6

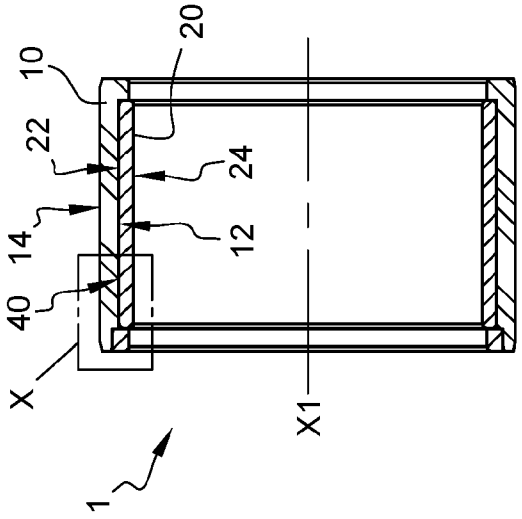


Fig. 9

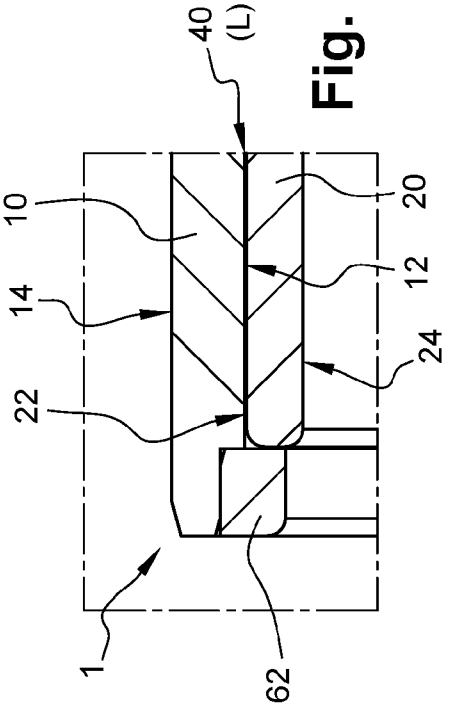


Fig. 10

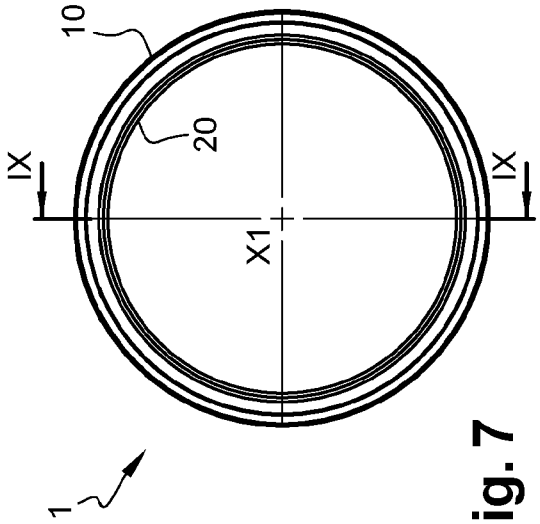


Fig. 7

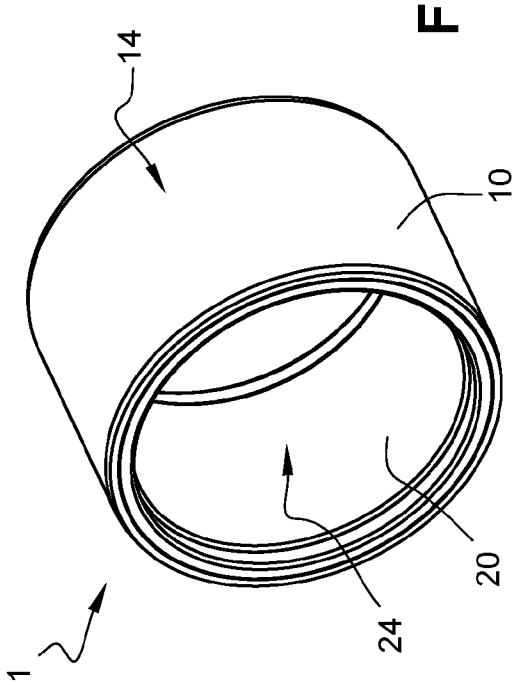


Fig. 8

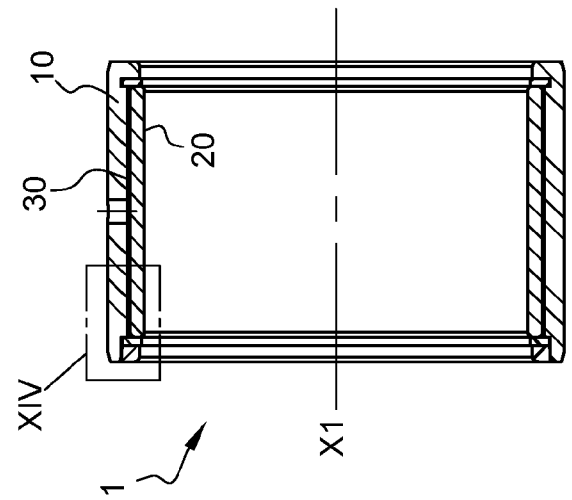


Fig. 13

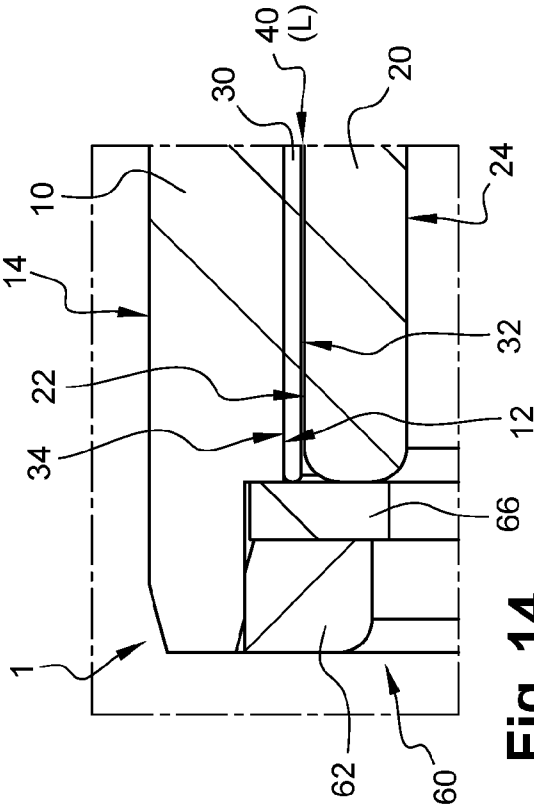


Fig. 14

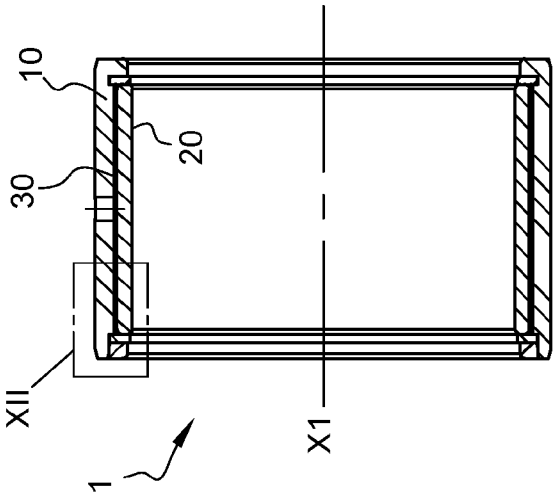


Fig. 11

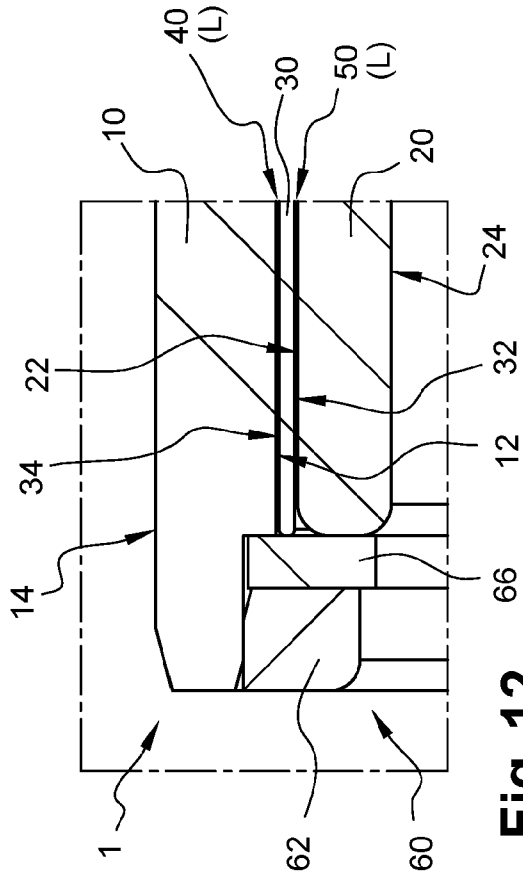


Fig. 12