



(51) International Patent Classification:

F16J 15/16 (2006.01) *F16J 15/32* (2006.01)
F16C 33/78 (2006.01) *F16J 15/447* (2006.01)
F16C 33/80 (2006.01)

(21) International Application Number:

PCT/EP2015/059730

(22) International Filing Date:

4 May 2015 (04.05.2015)

(25) Filing Language:

English

(26) Publication Language:

English

(30) Priority Data:

1409312.4 26 May 2014 (26.05.2014) GB

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(81) Designated States (unless otherwise indicated, for every kind of national protection available): AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BN, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IR, IS, JP, KE, KG, KN, KP, KR, KZ, LA, LC, LK, LR, LS, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PA, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SA, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

(84) Designated States (unless otherwise indicated, for every kind of regional protection available): ARIPO (BW, GH, GM, KE, LR, LS, MW, MZ, NA, RW, SD, SL, ST, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, RU, TJ, TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, KM, ML, MR, NE, SN, TD, TG).

Published:

— with international search report (Art. 21(3))

(54) Title: RADIAL SEAL WITH CONTACTING AND NON-CONTACTING PORTIONS

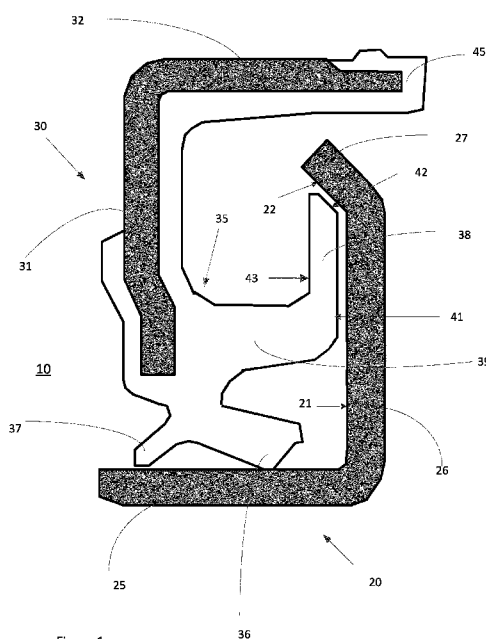


Figure 1a

(57) Abstract: The present invention resides in a seal unit for enclosing a radial gap between coaxial, relatively rotatable inner and outer members. The unit comprises a seal element (30) that is mountable to the outer member and comprises a flinger element (20) that is mountable to the inner member. The seal element has an elastomeric seal body (35) comprising a radial seal lip (36) that bears against a counterface on a cylindrical portion (25) of the flinger element. The flinger element further comprises a flange portion, having a first section (26) that extends in a purely radial direction from the cylindrical portion (25) and further comprises a second section (27) that extends from the first section (26) in an axially inward direction at an angle of between 10 and 80 degrees relative to a rotation axis of the unit. The elastomeric seal body further comprises a non-contact seal portion (38), which has a first surface (41) and a second surface (42) which respectively face the first and second sections (26, 27) of the flange portion, and which present an essentially constant gap (G) thereto of less than 1 mm.

Radial seal with contacting and non-contacting portions

FIELD OF THE INVENTION

The invention relates to a seal unit for enclosing a radial gap between relatively
5 rotatable coaxial components, whereby the seal comprises both a contact portion
in the form of a seal lip and a non-contact portion in the form of a labyrinth seal.

BACKGROUND TO THE INVENTION

An example of such a seal is described in US 7066467. The document discloses a
10 sealing device for a water pump bearing, which employs a seal member without an
axial lip, the seal member having a radial lip only. The sealing device further
comprises a flinger with a disk portion and an outer cylindrical portion. The seal
member has a section that is bent into an approximate U-shape in a region
corresponding radially along the disk portion of the flinger and axially along the
15 outer cylindrical portion. A labyrinth seal is thus formed by an axially extending and
a radially extending gap between the flinger and the bent section of the seal
member.

There is still room for improvement.

20

SUMMARY OF THE INVENTION

The present invention resides in a dynamic seal for enclosing a radial gap
between coaxial, relatively rotatable inner and outer members. The seal unit
comprises a flinger element which has a cylindrical portion adapted for mounting
25 to the inner member and has a flange portion that extends in a radially outward
direction from the cylindrical portion. The seal unit further comprises a seal
element, which has an annular casing with a sleeve part that is adapted for
mounting to the outer member. The seal element comprises an elastomeric seal
body, attached to the casing, and has a radially oriented seal lip that bears against
30 a counterface on the cylindrical portion of the flinger element. The flange portion of
the flinger has a first section that extends from the cylindrical portion in a purely
radial direction and has a second section that extends radially from the first section
in an axially inward direction, with an angle of between 10 and 80 degrees relative

to a rotation axis of the seal unit. The elastomeric seal body further comprises a non-contact seal portion with first and second surfaces which respectively face the first and second sections of the flange portion and present an essentially constant gap thereto with a gap width G of less than 1 mm.

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Thus, the seal unit comprises a labyrinth seal that is formed by a small gap between two sets of opposing surfaces. Two sections of the gap can therefore be defined. A first section of the gap extends in a purely radial direction between the first surface of the non-contact seal portion and the first section of the flinger flange. A second section of the gap extends in a radial and axial direction between the second section of the non-contact seal portion and the second section of the flinger flange.

During dynamic sealing conditions, the rotating part of the labyrinth seal excludes contaminants from entering the second section of the gap. The rotating part can be the flinger or the seal element. Contaminants such as moisture that adheres to the stationary part of the seal may nevertheless enter into the second section and then the first section of the gap. The moisture will eventually contact the rotating part of the seal and, under the action of centrifugal force, will be expelled from the first section of the gap. Centrifugal force is also able to expel the moisture from the second section of the gap, in that the opposing surfaces are angled relative to the seal rotation axis with an angle that is smaller than 90 degrees. Preferably, the angle is between 30 and 60 degrees.

Thus, the labyrinth seal is adapted not only to hinder the entry of contaminants, but also to optimise the expulsion of any contaminants that penetrate into the seal through the gap.

To enhance the labyrinth sealing effect, the length of gap sections is suitably greater than twice the width of the gap. Preferably, the first and second gap sections have a length of at least $5 \cdot G$.

In an advantageous development, the second section of the flange portion extends axially beyond the second surface of the non-contact seal portion. In other words, the entrance to the second section of the gap is covered by the second section of the flinger flange, which again helps to prevent the ingress of contaminants.

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In a further advantageous development, a radially inner surface of the sleeve part of the annular casing seal slopes away from the rotation axis of the seal unit. This helps to enable contamination to drain out of the seal unit.

10

Suitably, the annular casing of the seal unit comprises a flange part that extends in a radially inward direction from the sleeve part and the elastomeric seal body has an axial extension that extends from the flange part. The non-contact seal portion may be formed by a radial extension that extends from the axial extension. In a further advantageous development, the axial extension of the elastomeric seal

15 body has a radially inner surface that slopes away from the rotation axis of the seal unit. This helps to enable the drainage of contamination out of the first section of the gap.

20

A seal according to the invention has further advantages, which will become apparent from the following detailed description and accompanying figures.

DESCRIPTION OF THE FIGURES

In the following, the invention is described with reference to the accompanying drawings, in which:

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Figs.1a; 1b show a radial cross-section through part of a seal unit according to the invention;

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Fig. 1c shows a radial cross-section through the full seal unit.

DETAILED DESCRIPTION

Radial seals are employed to enclose a radial gap between coaxial, relatively rotatable components, such as a bearing outer ring and a bearing inner ring. The

seal serves to retain lubricant within the bearing and to exclude external contaminants, such as moisture and dirt. In applications where external contaminants are heavily present, e.g. wheel bearing applications, radial seals often have a radially oriented lip and an axially oriented lip that bear against
5 respectively oriented surfaces of a flinger component. During dynamic sealing conditions, the seal lips are in sliding contact with the flinger, which necessarily generates friction and eventually leads to wear.

A seal unit according to the invention is designed to provide sealing performance
10 which is equivalent to a seal with two lips, as described above, in terms of lubricant retention and contaminant exclusion capability, but which generates substantially lower friction. An example of such a unit is shown in Figures 1a, 1b and 1c. Each figure shows the same features, but the reference numerals associated with these features have been split over the three figures, in order not
15 to obscure any particular drawing.

The seal unit 10 comprises a flinger 20 that is adapted to be mounted to an inner component such as a shaft or a bearing inner ring, and further comprises a seal element 30 that is adapted to be mounted to an outer component such as a
20 housing or a bearing housing or a bearing outer ring. Let us assume that in the depicted example, the inner component is the rotatable component, meaning that the flinger 20 is the rotational part of the seal unit. It is also possible, however, for the sealing element 30 to be the rotational part.

25 The flinger 20 has a cylindrical portion 25 and a radially extending flange portion. The flange portion has a first section 26 that extends in a purely radial direction from the cylindrical portion 25, and has a second section 27 that extends from the first section 26 in an axially inward direction. The second section 27 extends at an angle α (refer Fig. 1b) relative to a rotation axis 60 (refer Fig. 1c) of the seal unit. In
30 the depicted example, the angle α is approximately 45 degrees, but may range from 10 to 80 degrees.

The seal element 30 comprises an annular casing with a sleeve part 32 that is mountable to a housing component, and a flange part 31 that extends radially from the sleeve part 32. The seal element further comprises an elastomeric body 35, which is e.g. moulded to the annular casing. The elastomeric body 35 is made of
5 NBR rubber in the depicted example, but any suitable elastomeric material may be used.

To ensure a seal under static conditions, the seal unit is provided with one sealing lip that bears against a counterface on the flinger. The elastomeric body has a
10 radial seal lip 36 that bears against a radially outer surface of the cylindrical portion 25 of the flinger. A radial seal lip has the advantage that under dynamic sealing condition, sliding contact between the radial lip 36 and the counterface takes place at the part of the seal with the smallest diameter, thereby minimising friction torque. In the depicted example, the elastomeric body 35 further comprises
15 a second radially oriented, non-contacting lip 37, which serves to retain grease within the sealed space.

To provide additional sealing capability in a low-friction manner, the seal unit comprises a labyrinth seal. The elastomeric body 35 has a non-contact seal
20 portion 38 which faces the flange portion of the flinger 20. The non-contact seal portion 38 extends in a radially outward direction from an axial extension part 39 of the elastomeric body, which itself extends from the flange part 31 of the annular casing. According to the invention, the non-contact seal portion 38 has a first surface 41 which runs parallel to an axially inner surface 21 of the first section 26
25 of the flinger flange, and has a second surface 42 which runs parallel to an axially inner surface 22 of the second section 27 of the flinger flange. The first and second surfaces 41, 42 of the non-contact seal portion 38 face the first and second sections 26, 27 of the flinger flange with an essentially constant gap G, which is less than 1 mm. Preferably, the gap G has a width of between 0.2 and 0.5
30 mm.

Thus, a labyrinth seal is formed by the gap G between two pairs of opposed surfaces. The first surface 41 of the non-contact seal portion 38 and the axially

inner surface 21 of the flinger will be referred to as the first pair of opposed surfaces; the second surface 42 of the non-contact seal portion 38 and the axially inner surface 22 of the flinger will be referred to as the second pair of opposed surfaces.

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The first pair of opposed surfaces 21, 41 are oriented perpendicular to the rotation axis 60 and have a length L_1 which is considerably greater than the gap width G . Preferably, the length L_1 is at least five times the gap width, as labyrinth sealing effect is enhanced by increasing the ratio of gap length to gap width. The second
10 pair of opposed surfaces 22, 42 are oriented with the angle α to the rotation axis 60 and have a length L_2 which is greater than the gap width G . Preferably, the length L_2 is at least twice the gap width.

During dynamic sealing, the rotating flinger 20 and the small axially oriented gap G
15 that is formed between the two pairs of opposed surfaces may initially cause an air-flow pumping effect that helps to prevent entry of contamination. However, it is likely due to the contact between the radial lip 36 and the flinger 20 that the seal unit 10 will reach an equilibrium state in which no air flow occurs. Nevertheless, any contamination that enters the gap G and makes contact with the rotating
20 flinger will be urged in a radially outward direction, due to centrifugal force. Furthermore, because the second section 27 of the flinger flange is angled at an angle α of less than 90 degrees, contamination does not become trapped, but can still move under the effect of centrifugal force and be ejected into a first collection chamber 50 of the seal unit.

25

The first collection chamber 50 is delimited at a radially inner side by the axial extension part 39 of the elastomeric body 35. At a radially outer side, the chamber 50 is delimited by a radially inner surface 47 of the sleeve part 32 of the annular casing. In the depicted example, this radially inner surface is formed by a part of
30 the elastomeric body 35 that is attached to the casing sleeve. To help prevent contamination from entering the first collection chamber 50, the sleeve part 32 of the annular casing has an overhang 45 that extends in an axially outward direction beyond the second section 27 of the flinger flange. In the depicted example, part

of the overhang 45 is formed by the elastomeric body and extends by an amount b (refer Fig. 2) beyond an axially outer surface of the first section 26 of the flinger flange. Thus at the entrance to the first collection chamber 50, contamination such as moisture will fall past the seal unit or fall onto the angled second section 27 of the flinger flange. During static conditions, moisture which falls onto the angled second section 27 will drain off; during dynamic sealing, the moisture will be flung away.

The second section 27 of the flinger flange extends towards the radially inner surface 47 of the casing sleeve 32, with a small radial gap in between. It remains possible, therefore, for contamination, e.g. moisture, to enter the first collection chamber 50 of the seal unit 10.

Contamination which has entered the first collection chamber 50 should then be inhibited from entering the gap G between the second pair of opposed surfaces 22, 42 of the labyrinth seal. To this end, the entrance is covered. In the depicted example, the second section 27 of the flinger flange extends beyond an axially inner surface 43 of the non-contact seal portion 38 by an amount a (refer Fig. 2), so that any contaminants on e.g. the radially inner surface 47 of the casing sleeve 32 cannot fall into the gap.

Advantageously, to enable contamination such as moisture to escape from the first collection chamber 50, the radially inner surface 47 of the casing sleeve 32 is angled relative to the rotation axis 60 with an angle β . As best seen in Fig 1c, gravity will cause the moisture to gather on the radially inner surface 47 of the casing sleeve, at a "six o'clock" position of the seal unit. This surface slopes away from the rotation axis 60, enabling the moisture to drain out of the seal unit.

The labyrinth seal is designed to prevent, as far as possible, the entry of contamination into a second collection chamber 55 of the seal unit, which lies radially inward of the first pair of opposing surfaces 21, 41 of the labyrinth seal. As mentioned above, the first pair of opposed surfaces and the angled second pair of

opposed surfaces 22, 42 of the labyrinth seal are designed to enable contaminants on the rotating flinger to be expelled into the first collection chamber 50.

Advantageously, the seal unit is further designed to enable contamination such as moisture, which adheres to the stationary elastomeric body 35, to escape from the second collection chamber 55. In the depicted example, a surface 44 of the elastomeric body that delimits the second collection chamber at a radially outer side is angled relative to the rotation axis 60 with an angle θ . Again as best seen in Fig. 1c, gravity will cause the moisture to gather on the surface 44, at a “six o'clock” position. This surface 44 slopes away from the rotation axis 60, enabling the moisture to drain into the labyrinth seal gap G and then into the first collection chamber 50. As explained above, the angled surface 47 that delimits the first collection chamber at a radially outer side then allows the moisture to drain out of the seal unit altogether.

Thus a seal unit according to the invention is not only designed to inhibit the entry of contaminants into the sealed space, it is also optimised in terms of permitting contaminants to be expelled from the seal unit.

A number of aspects/embodiments of the invention have been described. It is to be understood that each aspect/embodiment may be combined with any other aspect/embodiment. The invention may thus be varied within the scope of the accompanying patent claims.

Patent Claims:

1. Seal unit (10) for enclosing a radial gap between coaxial, relatively rotatable inner and outer members, the seal unit comprising:
 - 5 - a flinger element (20) comprising a cylindrical portion (25) adapted for mounting to the inner member and further comprising a flange portion that extends in a radially outward direction from the cylindrical portion; and
 - 10 - a seal element (30) comprising an annular casing having a sleeve part (32) adapted for mounting to the outer member and comprising an elastomeric seal body (35), attached to the casing, having a radially oriented seal lip (36) that bears against a counterface on the cylindrical portion (25) of the flinger element; wherein
 - 15 • the flange portion of the flinger has a first section (26) that extends from the cylindrical portion in a purely radial direction and has a second section (27) that extends radially from the first section in an axially inward direction, with an angle α of between 10 and 80 degrees relative to a rotation axis (60) of the seal unit; and
 - 20 • the elastomeric seal body (35) further comprises a non-contact seal portion (38) with first and second surfaces (41, 42) which respectively face the first and second sections (26, 27) of the flange portion and present an essentially constant gap (G) thereto of less than 1 mm.
- 25 2. Seal unit according to claim 1, wherein the first and second surfaces (41, 42) of the non-contact seal portion have a length greater than $2 \cdot G$.
3. Seal unit according to claim 1 or 2, wherein the first surface (41) of the non-contact seal portion has a length greater than $5 \cdot G$.
- 30 4. Seal unit according to any preceding claim, wherein a periphery of the second section (27) of the flange portion extends axially beyond the second surface (42) of the non-contact seal portion (38).

5. Seal unit according to any preceding claim, wherein a radially inner surface (47) of the sleeve part (32) of the annular casing seal slopes away from the rotation axis (60) of the seal unit with an angle (β).
- 5 6. Seal unit according to any preceding claim, wherein:
- the annular casing comprises a flange part (31) that extends in a radially inward direction from the sleeve part (32);
 - 10 • the elastomeric seal body comprises an axial extension (39) that extends from the flange part (31);
 - the non-contact seal portion (38) is formed by a radial extension that extends from the axial extension; and
 - the axial extension (39) of the elastomeric seal body (35) has a radially inner surface (44) that slopes away from the rotation axis (60) of the seal unit with an angle (θ).
- 15 7. Seal unit according to any preceding claim, wherein the sleeve part (32) of the annular casing has an overhang (45) that extends in axial direction beyond a radial periphery of the second section (27) of the flange portion of the flinger (20).
- 20 8. Seal unit according to claim 7, wherein the overhang (45) extends in axial direction beyond an axially outer surface of the first section (26) of the flange portion of the flinger (20).

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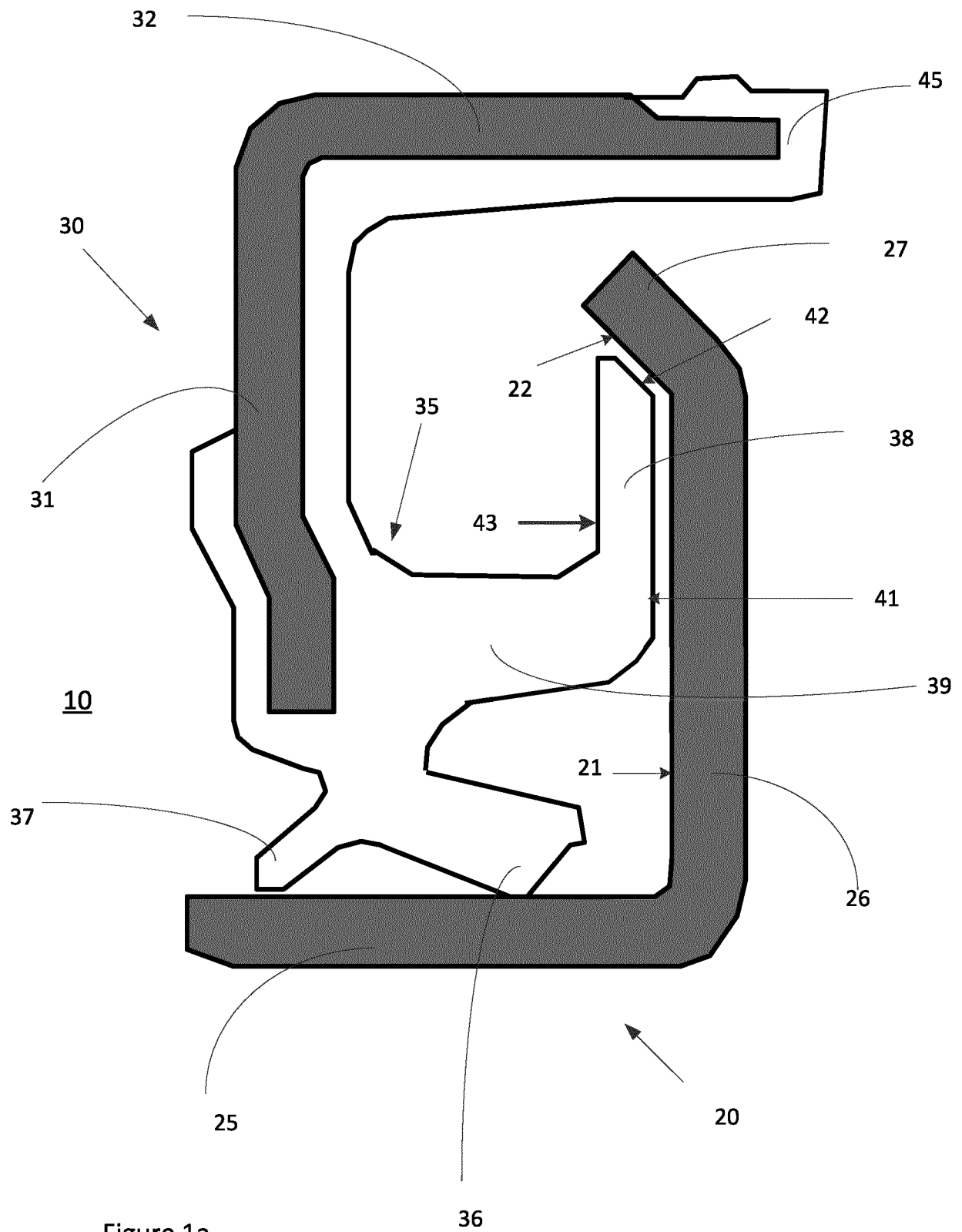


Figure 1a

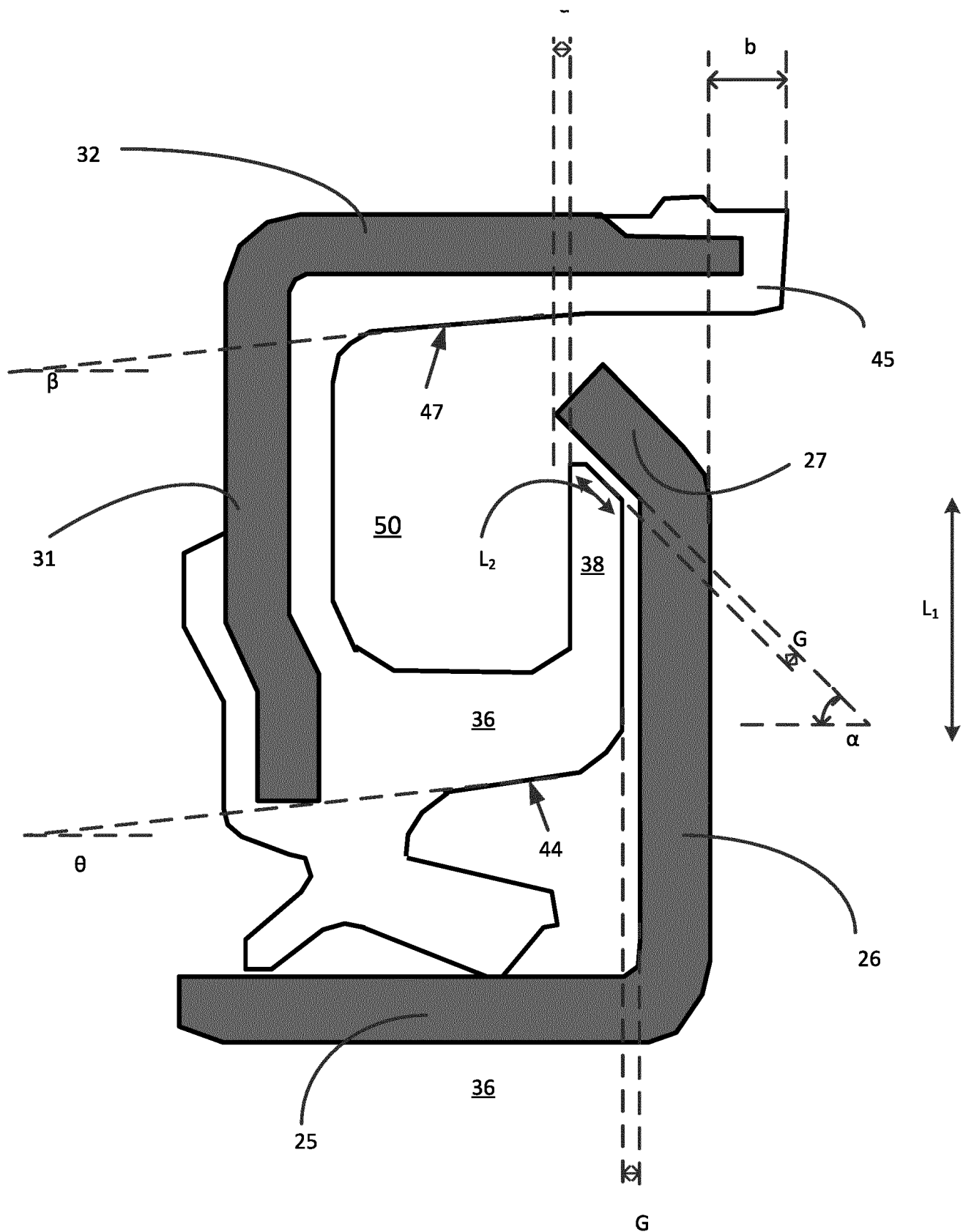
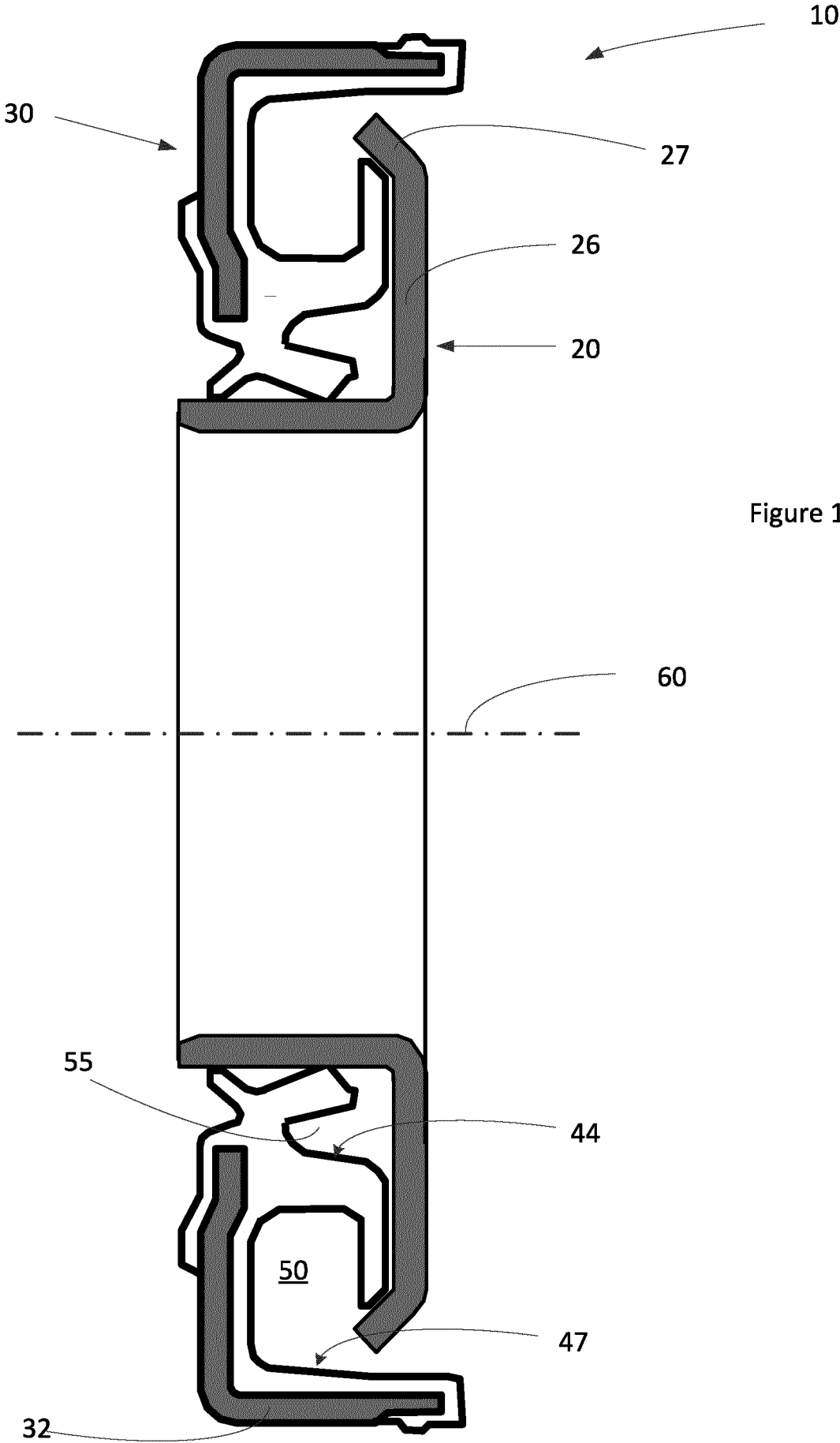


Figure 1b



INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2015/059730

A. CLASSIFICATION OF SUBJECT MATTER
INV. F16J15/16 F16C33/78 F16C33/80 F16J15/32 F16J15/447
ADD.

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
F16J F16C

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	JP 2003 240003 A (NSK LTD) 27 August 2003 (2003-08-27) abstract paragraph [0023] figures 1-8	1,2,5-8
X	----- EP 0 172 881 A1 (FEDERAL MOGUL CORP [US]) 5 March 1986 (1986-03-05) column 6, lines 8-42 figures 3-5	1-3,5-8
A	----- US 2009/127795 A1 (LATTIME SCOTT B [US] ET AL) 21 May 2009 (2009-05-21) paragraphs [0021] - [0022] figures 1-4, 4A, 4B, 4C -----	1-8



Further documents are listed in the continuation of Box C.



See patent family annex.

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"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

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Date of the actual completion of the international search

29 June 2015

Date of mailing of the international search report

06/07/2015

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INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

PCT/EP2015/059730

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