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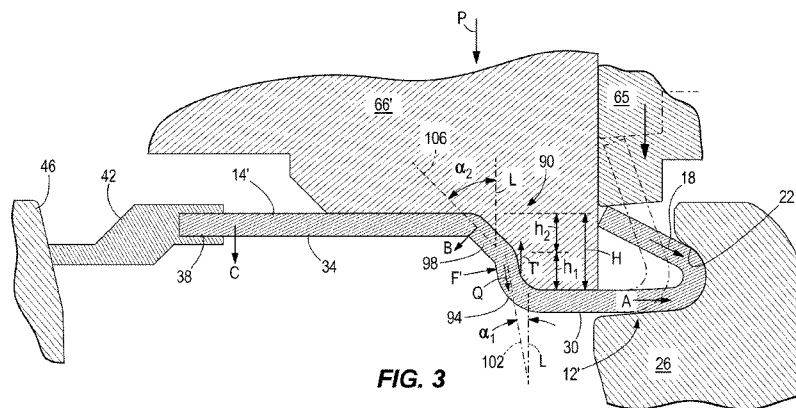
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(54) Title: BEARING SEAL



(57) Abstract: A seal for use with a bearing assembly defining a bearing axis. The seal includes a seal case (14') having a bend lip section (18) configured to be positioned into a groove (22) in a component of the bearing assembly, a first section (30) extending from the bend lip section, a second section (34) offset axially from the first section, and a transition section (90) extending between the first section and the second section to provide the offset between the first and second sections. The transition section defines a neutral axis forming an angle α with a line L parallel to the bearing axis, and the angle α is less than or equal to 20° . A seal lip (42) is coupled to the second section and is configured for sealing engagement with a component of the bearing assembly.

BEARING SEAL

RELATED APPLICATIONS

[0001] This application claims the benefit of U.S. Provisional Patent Application No. 62/134,842 filed March 18, 2015, the entire content of which is hereby incorporated by reference.

BACKGROUND

[0002] The present invention relates to bearings, and more particularly to seals for bearings.

[0003] In various applications of rolling element bearings in a harsh environment, it is known to seal the bearing securely to prevent either solid or liquid contaminants from entering the bearing, as well as securely sealing the grease in the bearing from leaking. One type of seal includes a disk-like thin sheet case, often called a seal case, conventionally made of sheet metal (e.g., steel), and an elastomeric (e.g., rubber) seal lip coupled to the sheet metal seal case. The seal is mounted on the bearing by means of a deformation process in which an outer diameter portion of the seal case is pressed into a groove in the outer bearing ring or race. This mounting technique secures the seal case against any rotation or pop-up during operation while the rubber seal lip is in tight contact with the outer surface of the inner bearing ring. Fig. 1 illustrates a conventional bearing assembly 10 with two seals 12.

[0004] The seal cases 14 of the seals 12 are substantially identical, and each includes a bend lip section 18 at the outer diameter that is configured to be pressed/deformed into a groove 22 formed in the outer bearing ring 26. Fig. 1 illustrates both the final deformed shape as well as the preform shape of the lip section 18. A first section 30 extends radially inwardly from the lip section 18. A second section 34 is axially offset from the first section 30 (i.e., offset axially outwardly relative to the radial centerline 36 of the bearing assembly 10), and extends radially inwardly to a distal end 38. The elastomeric seal lip 42 is coupled to the distal end 38 of the seal case 14 and extends radially inwardly to sealingly engage the outside diameter of the inner bearing ring 46. A transition section 50 of the seal case 14 extends between the first section 30 and the second section 34 to provide the axial offset to the seal case 14. In conventional seal cases 14, the transition section 50 is defined by a bend

in the sheet metal material. The transition section 50 has a neutral axis 54 (see Fig. 2) defined through the center of the sheet metal material.

[0005] Since the available space for hosting a seal is usually very limited, the seals 12 must be mounted in such a way that the seal cases 14 can maintain their designed position and geometry as closely and consistently as possible so that the seal lips 42 will neither come out of the bearing face plane (outward distortion) nor contact the rolling elements 56 and cage 62 (inward distortion).

SUMMARY

[0006] Referring to both Figs. 1 and 2, typically, the neutral axis 54 of the transition section 50 forms an angle α with a line L parallel to the axis 58 of the bearing assembly 10. The angle α is typically larger than 35° , and is often about 45° . The inventor has found that the seal case 14 having this configuration could experience distortion during the mounting process to insert the seal case 14 into the bearing's outer ring 26. As a result, the seal case 14 exhibits horizontal displacements in both directions at location D of Fig. 1. This causes the seal lip 42 to be out of the positioning tolerance. This can also result in gaps between the seal lip 42 and the inner ring 46 when misalignment of the inner ring 46 occurs. The distortion is also generally inconsistent among the mounted seal cases 14.

[0007] The present invention reduces the distortion in a seal case when it is mounted into a rolling element bearing. The reduction in distortion of the seal case is achieved by novel configurations of the transition section. Particularly, either a dual-angle transition section or a single, reduced-angle transition section can be created so that distortion in the seal case previously observed during the mounting process can be significantly minimized. Furthermore, the reduced deformation that does occur, occurs with greater consistency and predictability.

[0008] In one embodiment, the invention provides a seal for use with a bearing assembly defining a bearing axis. The seal includes a seal case having a bend lip section configured to be positioned into a groove in a component of the bearing assembly, a first section extending from the bend lip section, a second section offset axially from the first section, and a transition section extending between the first section and the second section to provide the offset between the first and second sections. The transition section defines a neutral axis

forming an angle α_1 with a line L parallel to the bearing axis, and the angle α_1 is less than or equal to 20° . A seal lip is coupled to the second section and is configured for sealing engagement with a component of the bearing assembly.

[0009] In another embodiment, the invention provides a method of installing a seal on a bearing assembly defining a bearing axis. The seal is provided with a bend lip section in an un-deformed state, a first section extending from the bend lip section, a second section offset axially from the first section, and a transition section extending between the first section and the second section. The transition section defines a neutral axis forming an angle α_1 with a line L parallel to the bearing axis, the angle α_1 being less than or equal to 20° . A hold-down die is abutted against at least a portion of the first section, the second section, and the transition section. The bend lip section is pressed into a groove in a component of the bearing assembly, resulting in the bend lip section achieving a deformed state. The angle α_1 prevents deflection of the second section away from the hold-down die during the pressing of the bend lip section into the groove.

[0010] In yet another embodiment, the invention provides a seal for use with a bearing assembly defining a bearing axis. The seal includes a seal case having a bend lip section configured to be positioned into a groove in a component of the bearing assembly, a first section extending from the bend lip section, a second section offset axially from the first section, and a transition section extending between the first section and the second section to provide the offset between the first and second sections. The transition section comprises a first linear segment and a second linear segment. The first linear segment defines a neutral axis forming an angle α_1 with a line L parallel to the bearing axis, and the angle α_1 is less than or equal to 20° . The second linear segment defines a neutral axis forming an angle α_2 with the line L parallel to the bearing axis, and the angle α_2 is greater than or equal to 35° . A seal lip is coupled to the second section and is configured for sealing engagement with a component of the bearing assembly.

[0011] Other aspects of the invention will become apparent by consideration of the detailed description and accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

[0012] Fig. 1 is a partial section view of a prior art bearing assembly having two seals.

[0013] Fig. 2 is a schematic view of the prior art seal case of Fig. 1, illustrating forces acting on the seal case during installation into a bearing ring.

[0014] Fig. 3 is a partial section view of a seal case according to the invention.

[0015] Fig. 4 is a partial section view of another embodiment of a seal case according to the invention.

DETAILED DESCRIPTION

[0016] Before any embodiments of the invention are explained in detail, it is to be understood that the invention is not limited in its application to the details of construction and the arrangement of components set forth in the following description or illustrated in the following drawings. The invention is capable of other embodiments and of being practiced or of being carried out in various ways.

[0017] Fig. 2 schematically illustrates the prior art seal case 14 of the seal 12 of Fig. 1, and the forces acting on the seal case 14 during installation onto the bearing assembly 10. As illustrated in Fig. 2, the seal case 14 is oriented horizontally, rotated 90° relative to the orientation of Fig. 1. A punch 65, with the help of a hold-down die 66, pushes the bend lip section 18 of the seal case 14 downwards (in the orientation shown in Fig. 2) from an initially un-deformed state to a deformed state so that the lip portion 18 bends and is forced securely into the groove 22 of the outer ring 26. Even though the majority of the filling of the groove 22 comes from the lip section 18, there is a force A that pulls the material of the first section 30 into the groove 22. When this happens, the transition section 50, with its angle α of about 45°, experiences a relatively large pulling force Q that overcomes the smaller resistance force F and friction force T provided by the hold-down die 66. Therefore the material of the transition section 50 tends to flow underneath the hold-down die 66. As a result, the transition section 50 at B and the second section 34 at C will bend away from the hold-down die 66 (downwardly in Fig. 2) to displace from their initial positions. It has been determined by the inventors that a lack of resistance to the pulling force Q is the main reason for distortion of the seal case 14 that occurs during the mounting process.

[0018] A brief explanation of the hold-down die 66 will explain how flow can occur beneath the hold-down die 66. The hold-down die 66 is not fixed. It is allowed to move up and down a pre-determined distance. The hold-down die 66 is spring loaded. Above the

hold-down die 66, there is a spacer (not shown). Between the spacer and the hold-down die 66, there is a spring (not shown), which biases the hold-down die 66 downwards (in the orientation shown in Fig. 2). During seal case mounting, the hold-down die 66 can move up or down depending on which force, either the forming force or the spring force, is greater. By adjusting the spacer's thickness and the spring's load rating, the hold-down die's moving distance is altered, which may have some influence on the seal case's axial position.

[0019] The present invention addresses the above issues by increasing the resistance forces between the hold-down die and the transition section of the seal case so that the seal case is mounted to the rolling element bearing precisely, without causing intolerable distortion. The targeted performance of the seal case in the mounting process is achieved by implementing new configurations of the transition section in the seal case.

[0020] Fig. 3 illustrates a seal case 14' of the present invention operable for use in place of the prior art seal cases 14 and seals 12 on the bearing assembly 10 shown in Fig. 1. Like parts have been given like reference numerals. It is also to be understood that while the illustrated bearing assembly 10 is a spherical roller bearing assembly, the seal case 14' and seal 12' (and the seal case 14'' and seal 12'' discussed below) can also be used with other types of rolling element bearing assemblies. The seal case 14' has a body portion with a bend lip section 18 at the outer diameter that is configured to be pressed/deformed into the groove 22 formed in the outer bearing ring 26. Fig. 3 illustrates both the final deformed shape as well as the preform shape of the bend lip section 18. The body portion further includes a first section 30 that extends radially inwardly from the bend lip section 18. A second section 34 is axially offset from the first section 30 by an offset distance H (i.e., offset axially outwardly relative to the radial centerline 36 of the bearing assembly 10), and extends radially inwardly to a distal end 38. In the illustrated embodiment, the first and second sections 30 and 34 are substantially parallel, however, in other embodiments they may not be parallel. The seal case 14' is made of sheet metal (e.g., steel). The elastomeric seal lip 42 of the seal 12' (not shown in Fig. 3) is coupled to the distal end 38 and extends radially inwardly to sealingly engage the inner bearing ring 46.

[0021] The difference between the prior art seal case 14 and the seal case 14' relates to the transition section. The transition section 90 of the seal case 14' extends between the first section 30 and the second section 34 to provide the axial offset to the seal case 14'. As illustrated in Fig. 3, the transition section 90 includes a first segment 94 and a second

segment 98. As shown in Fig. 3, both the first and second segments 94, 98 are linear segments in that the sheet metal material is bent to provide segments that have a longitudinal length greater than the thickness of the sheet metal material. The first linear segment 94 defines a neutral axis 102 and is directly connected to the first section 30. The second linear segment defines a neutral axis 106 and is directly connected to the second section 34. Those skilled in the art will understand that the term “neutral axis,” as used herein and in the appended claims, refers to an axis taken through the mid-plane of the sheet metal’s thickness.

[0022] The transition section 90 can be referred to as a dual-angle, transitional slope section. As shown in Fig. 3, two angles, α_1 and α_2 , with different values, divide equally (as shown) or unequally (not shown), the offset distance H into two, axial height zones h_1 and h_2 . In the axially outer zone h_2 , the slope angle α_2 maintains the same or similar angle value as α , such as greater than or equal to 35° (e.g., 45°), like the prior art seal case 14 shown in Figs. 1 and 2. Again, the angle α_2 is defined between the neutral axis 106 and a line L parallel to the bearing axis 58. In the axially inner zone h_1 , the slope angle α_1 , formed between the neutral axis 102 and a line L parallel to the bearing axis 58, is less than or equal to 20° . In some embodiments the angle α_1 is less than or equal to 15° , or less than or equal to 10° , or less than or equal to 5° . In yet other embodiments, the angle α_1 is between 2.5° and 20° . As illustrated in Fig. 3, the angle α_1 is between about 5° to about 10° . The term “about,” as used herein and in the appended claims to describe potential variation in angles, means plus or minus 2.5° .

[0023] The hold-down die 66’ is modified to conform to the inventive geometry of the seal case 14’, and specifically to the transition section 90, as shown in Fig. 3. The inventors have found that with the geometry of the transition section 90 shown in Fig. 3, the resistant force F’ and friction force T’ are both at least doubled relative to the prior art resistant force F and friction force T shown in Fig. 2. With the substantially increased resistant force F’ and friction force T’, the material flow adjacent the hold-down die 66’, as caused by the pulling forces Q and A, is effectively reduced or completely stopped. As a result, the deflections of the seal case 14’ at the second section 34 (i.e., near the location C) and at the transition section 90 (i.e. near the location B) will be negligible. It has been found that the significant change from angle α_1 to α_2 creates an obstruction that severely impedes the material flow of the seal case 14’ in the area adjacent the hold-down die 66’, acting to effectively reduce the overall distortion of the seal case 14’ during installation.

[0024] Fig. 4 illustrates another embodiment of a seal case 14'' of the invention. Like parts have been given like reference numerals. The seal case 14'' is used in applications in which the rolling element bearing 10 has small dimensions such that manufacturing a seal 12' having a seal case 14' with the transition section 90 can be a challenge. Namely, it may be difficult to implement the two linear segments 94, 98, with the respective angles α_1 and α_2 , with satisfactory precision when the distance H needs to be very small. Therefore, a modified configuration of a seal 12'' with a seal case 14'' having a transition section 120 that can be referred to as a single, reduced-angle transitional slope, can be utilized, as long as the angle α_1 is sufficiently small.

[0025] The seal case 14'' has only a single linear segment 124 in its transition section 120. That linear segment 124 is short, due to the small axial offset H, and defines a neutral axis 128. An angle α_1 is defined between the neutral axis 128 and a line L parallel to the bearing axis 58. The angle α_1 is less than or equal to 20° . In some embodiments the angle α_1 is less than or equal to 15° , or less than or equal to 10° , or less than or equal to 5° . In yet other embodiments, the angle α_1 is between 2.5° and 20° . As illustrated in Fig. 4, the angle α_1 is between about 5° to about 10° . With this transition section 120, the radii of R_1 and R_2 are defined by the bends in sheet metal between the first section 30 and the transition section 120, and the second section 34 and the transition section 120, respectively. These radii R_1 and R_2 decrease as the angle α_1 decreases. In situations where the axial offset H must be even smaller, the transition section may be so short that it does not include a linear segment. In such a case, the angle α_1 would be deemed to be about 0° at an inflection point between the radii R_1 and R_2 .

[0026] The hold-down die 66'' is modified to conform to the inventive geometry of the seal case 14'', and specifically to the transition section 120, as shown in Fig. 4. The inventors have found that with the geometry of the transition section 120 shown in Fig. 4, the resistant force F'' and friction force T'' are both at least doubled relative to the prior art resistant force F and friction force T shown in Fig. 2. With the substantially increased resistant force F'' and friction force T'' , the material flow adjacent the hold-down die 66'', as caused by the pulling forces Q and A, is effectively reduced or completely stopped. As a result, the deflections of the seal case 14'' at the second section 34 (i.e., near the location C) and at the transition section 120 (i.e. near the location B) will be negligible. It has been found that the significantly small angle α_1 creates an obstruction that severely impedes the material flow of

the seal case 14'' in the area adjacent the hold-down die 66'', acting to effectively reduce the overall distortion of the seal case 14'' during installation.

[0027] Various features and advantages of the invention are set forth in the following claims.

CLAIMS

What is claimed is:

1. A seal for use with a bearing assembly defining a bearing axis, the seal comprising:
 - a seal case having
 - a bend lip section configured to be positioned into a groove in a component of the bearing assembly;
 - a first section extending from the bend lip section;
 - a second section offset axially from the first section; and
 - a transition section extending between the first section and the second section to provide the offset between the first and second sections, the transition section defining a neutral axis forming an angle α_1 with a line L parallel to the bearing axis, the angle α_1 being less than or equal to 20° ; and
 - a seal lip coupled to the second section and configured for sealing engagement with a component of the bearing assembly.
2. The seal of claim 1, wherein the seal lip engages an inner bearing ring of the bearing assembly.
3. The seal of claim 1, wherein the bend lip section is sheet metal deformable from an initial un-deformed state to a deformed state when positioned in the groove.
4. The seal of claim 1, wherein the angle α_1 is less than or equal to 15° .
5. The seal of claim 4, wherein the angle α_1 is less than or equal to 10° .
6. The seal of claim 5, wherein the angle α_1 is less than or equal to 5° .
7. The seal of claim 1, wherein the angle α_1 is between about 5° and about 10° .
8. The seal of claim 1, wherein the angle α_1 is between 2.5° and 20° .
9. The seal of claim 1, wherein the transition section includes a linear segment defining the neutral axis.

10. The seal of claim 1, wherein the transition section includes a first linear segment defining the neutral axis forming the angle α_1 , and a second linear segment extending from the first linear segment.

11. The seal of claim 10, wherein the first linear segment is directly connected to the first section and wherein the second linear segment is directly connected to the second section.

12. The seal of claim 11, wherein the second linear segment defines a neutral axis forming an angle α_2 with the line L parallel to the bearing axis, and wherein the angle α_2 is greater than or equal to 35° .

13. The seal of claim 10, wherein the first linear segment defines an axial height that is substantially equal to an axial height of the second linear segment.

14. The seal of claim 1, wherein the transition section includes only a single linear segment defining the neutral axis.

15. The seal of claim 1, wherein the seal lip is elastomeric.

16. The seal of claim 1, wherein the first and second sections are substantially parallel.

17. A method of installing a seal on a bearing assembly defining a bearing axis, the method comprising:

providing the seal with a bend lip section in an un-deformed state, a first section extending from the bend lip section, a second section offset axially from the first section, and a transition section extending between the first section and the second section, the transition section defining a neutral axis forming an angle α_1 with a line L parallel to the bearing axis, the angle α_1 being less than or equal to 20° ;

abutting a hold-down die against at least a portion of the first section, the second section, and the transition section;

pressing the bend lip section into a groove in a component of the bearing assembly, resulting in the bend lip section achieving a deformed state,

wherein the angle α_1 prevents deflection of the second section away from the hold-down die during the pressing of the bend lip section into the groove.

18. The method of claim 17, wherein the seal further comprises a seal lip coupled to the second section, and the method includes abutting the seal lip into sealing engagement with a component of the bearing assembly.

19. The method of claim 17, wherein the transition section includes a first linear segment defining the neutral axis forming the angle α_1 , and a second linear segment extends from the first linear segment.

20. The method of claim 19, wherein the first linear segment directly connects to the first section and the second linear segment directly connects to the second section.

21. The seal of claim 20, wherein the second linear segment defines a neutral axis forming an angle α_2 with the line L parallel to the bearing axis, and wherein the angle α_2 is greater than or equal to 35° .

22. The seal of claim 19, wherein the first linear segment defines an axial height that is substantially equal to an axial height of the second linear segment.

23. The seal of claim 19, wherein a surface of the hold-down die conforms to a geometry of the first section, the transition section, and the second section.

24. The seal of claim 17, wherein a surface of the hold-down die conforms to a geometry of the first section, the transition section, and the second section.

25. A seal for use with a bearing assembly defining a bearing axis, the seal comprising:

a seal case having

a bend lip section configured to be positioned into a groove in a component of the bearing assembly;

a first section extending from the bend lip section;

a second section offset axially from the first section; and

a transition section extending between the first section and the second section to provide the offset between the first and second sections, the transition section comprising a first linear segment and a second linear segment,

the first linear segment defining a neutral axis forming an angle α_1 with a line L parallel to the bearing axis, the angle α_1 being less than or equal to 20° ; and

the second linear segment defining a neutral axis forming an angle α_2 with the line L parallel to the bearing axis, the angle α_2 being greater than or equal to 35° ; and

a seal lip coupled to the second section and configured for sealing engagement with a component of the bearing assembly.

26. The seal case of claim 25, wherein the first linear segment directly connects to the first section and the second linear segment directly connects to the second section.

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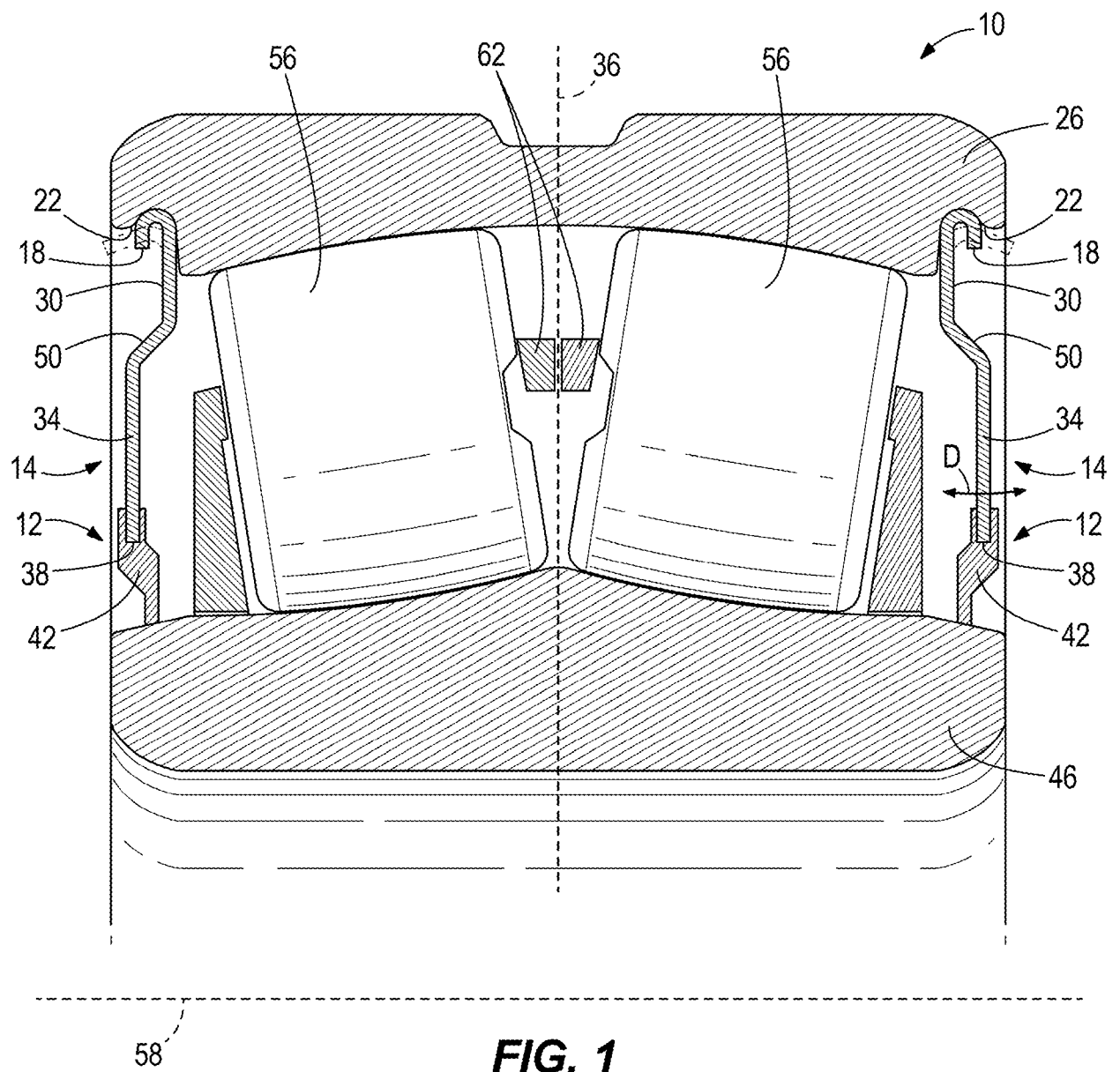


FIG. 1
PRIOR ART

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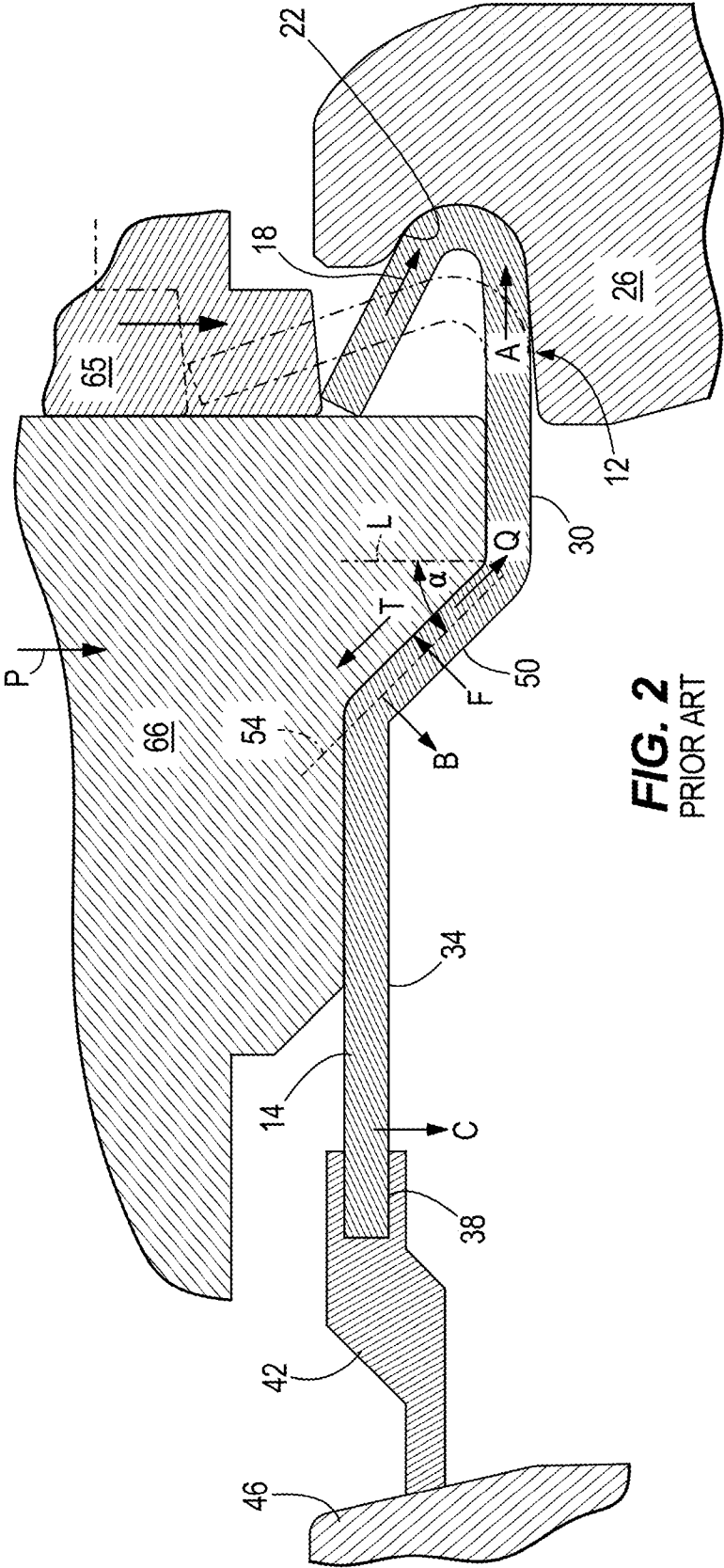


FIG. 2
PRIOR ART

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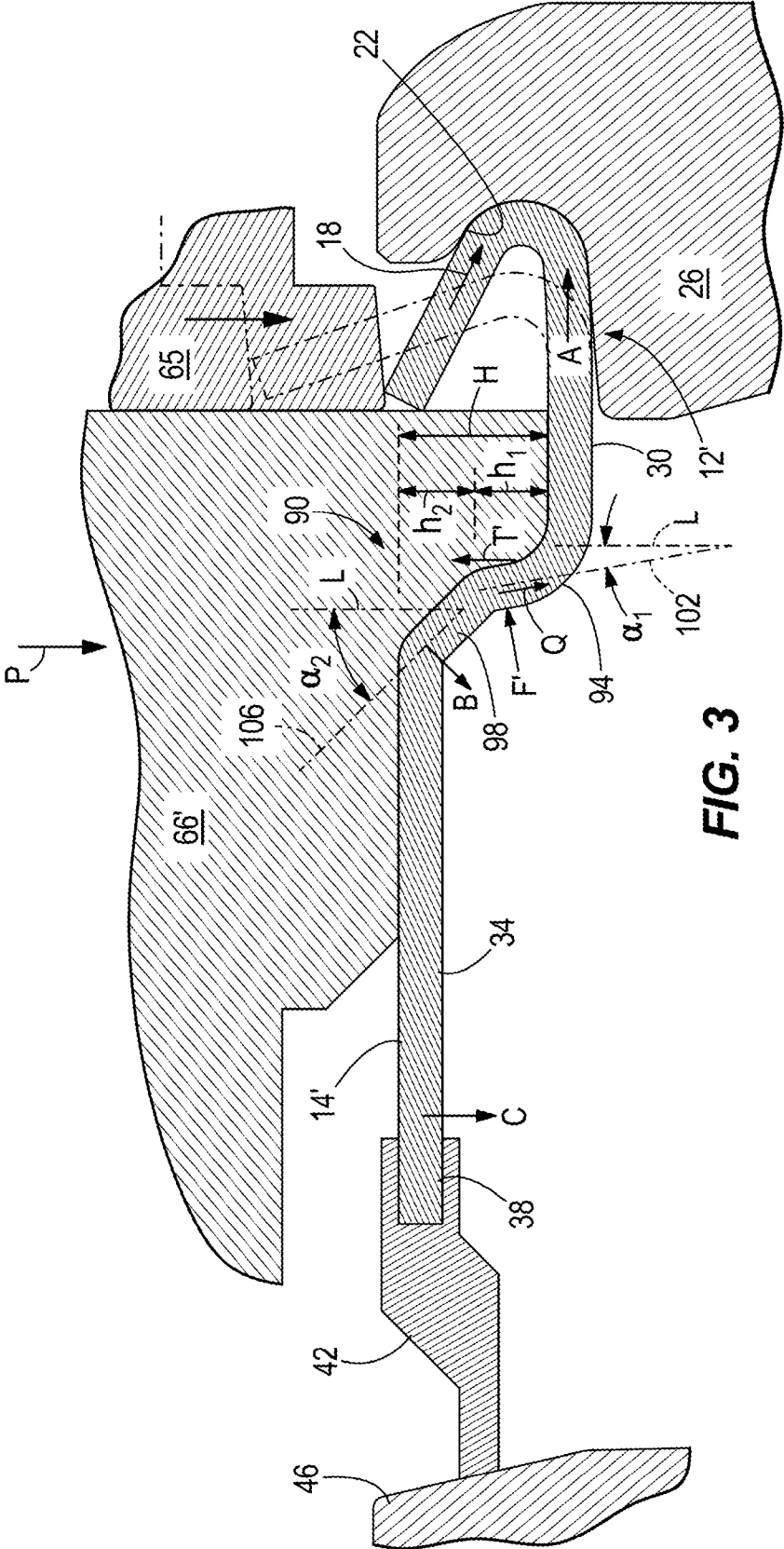


FIG. 3

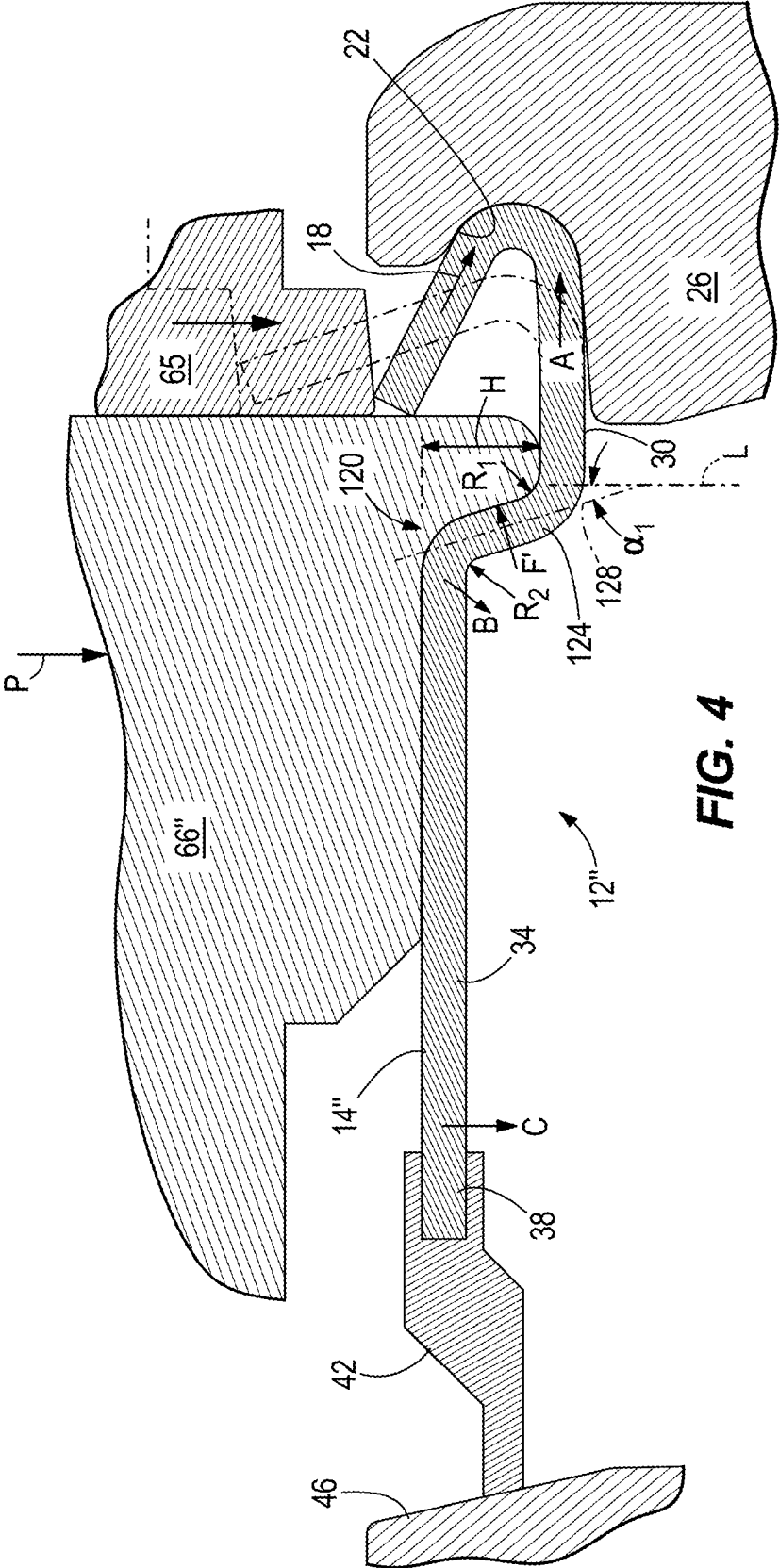


FIG. 4

INTERNATIONAL SEARCH REPORT

International application No
PCT/US2016/021818

A. CLASSIFICATION OF SUBJECT MATTER

INV. F16C33/78 F16C43/04
ADD. F16C23/08

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)
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	US 5 472 284 A (ALLING RICHARD L [US] ET AL) 5 December 1995 (1995-12-05) column 3, lines 7-40 column 2, lines 50-60 figures 1-3	1-12, 14-18, 24
X	DE 19 40 357 U (ZILLER & CO [DE]) 8 June 1966 (1966-06-08) page 4 figures	1-6, 9-11, 15-21, 24-26
X	US 3 994 545 A (VAN DORN HORACE B) 30 November 1976 (1976-11-30) column 2, lines 3-25 figures ----- -/-	1-12, 15-21, 23-26



Further documents are listed in the continuation of Box C.



See patent family annex.

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Date of the actual completion of the international search

31 May 2016

Date of mailing of the international search report

09/06/2016

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Dumont, Marie-Laure

INTERNATIONAL SEARCH REPORT

International application No

PCT/US2016/021818

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 3 032 346 A (SULLIVAN JAMES M) 1 May 1962 (1962-05-01) column 2, lines 59-72 figures 1-3	1-26
A	----- JP 2008 207259 A (NSK LTD) 11 September 2008 (2008-09-11) abstract figures -----	1-26

INTERNATIONAL SEARCH REPORT

Information on patent family members

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