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Matsushima et al.

[11] E

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[54] **SEALING DEVICE**
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both of Fukushima, Japan
[73] Assignee: **NOK Corporation, Tokyo, Japan**

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4,448,426 5/1984 Jackowski et al. 277/37
4,981,303 1/1991 Matsushima 277/37

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[21] Appl. No.: **263,403**
[22] Filed: **Jun. 21, 1994**

2082269 3/1982 United Kingdom .

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Attorney, Agent, or Firm—Armstrong, Westerman, Hattori,
McLeland & Naughton

Related U.S. Patent Documents

Reissue of:

[64] Patent No.: **4,981,303**
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Appl. No.: **425,900**
Filed: **Oct. 24, 1989**

U.S. Applications:

[63] Continuation of Ser. No. 66,936, May 25, 1993, abandoned,
which is a continuation of Ser. No. 855,058, Mar. 19, 1992,
abandoned.

Foreign Application Priority Data

Oct. 25, 1988 [JP] Japan 63-139031 U
Dec. 23, 1988 [JP] Japan 63-166542 U

[51] Int. Cl.⁶ **F16J 15/34; F16J 15/32**

[52] U.S. Cl. **277/37; 277/35; 277/38;**
277/53; 277/152

[58] Field of Search **277/35, 36, 37,**
277/38, 53, 56, 199, 152

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3,510,138 5/1970 Bowen et al. 277/35

[57] **ABSTRACT**

A sealing device comprising a projected portion having a rubber-like elastic member on the outer periphery of a seal member, an outer cylindrical portion extending toward the seal member on a flange portion of a sleeve member. This outer cylindrical portion covers an opening formed between the seal member and the flange portion, thereby preventing entry of dust. The outer cylindrical portion is further provided on the tip thereof with a bend portion which can be engaged with the projected portion. The projected portion, the outer cylindrical portion, and the bend portion form a small clearance which serves as a labyrinth seal. The projected portion is fixedly fitted with a projection ring for covering the opening formed between the seal member and the flange portion of the sleeve member so that the free end portion of the projection ring can be engaged with the flange. This free end portion of the protection ring and the flange portion form a small clearance, and this small clearance serves as a labyrinth seal.

5 Claims, 5 Drawing Sheets

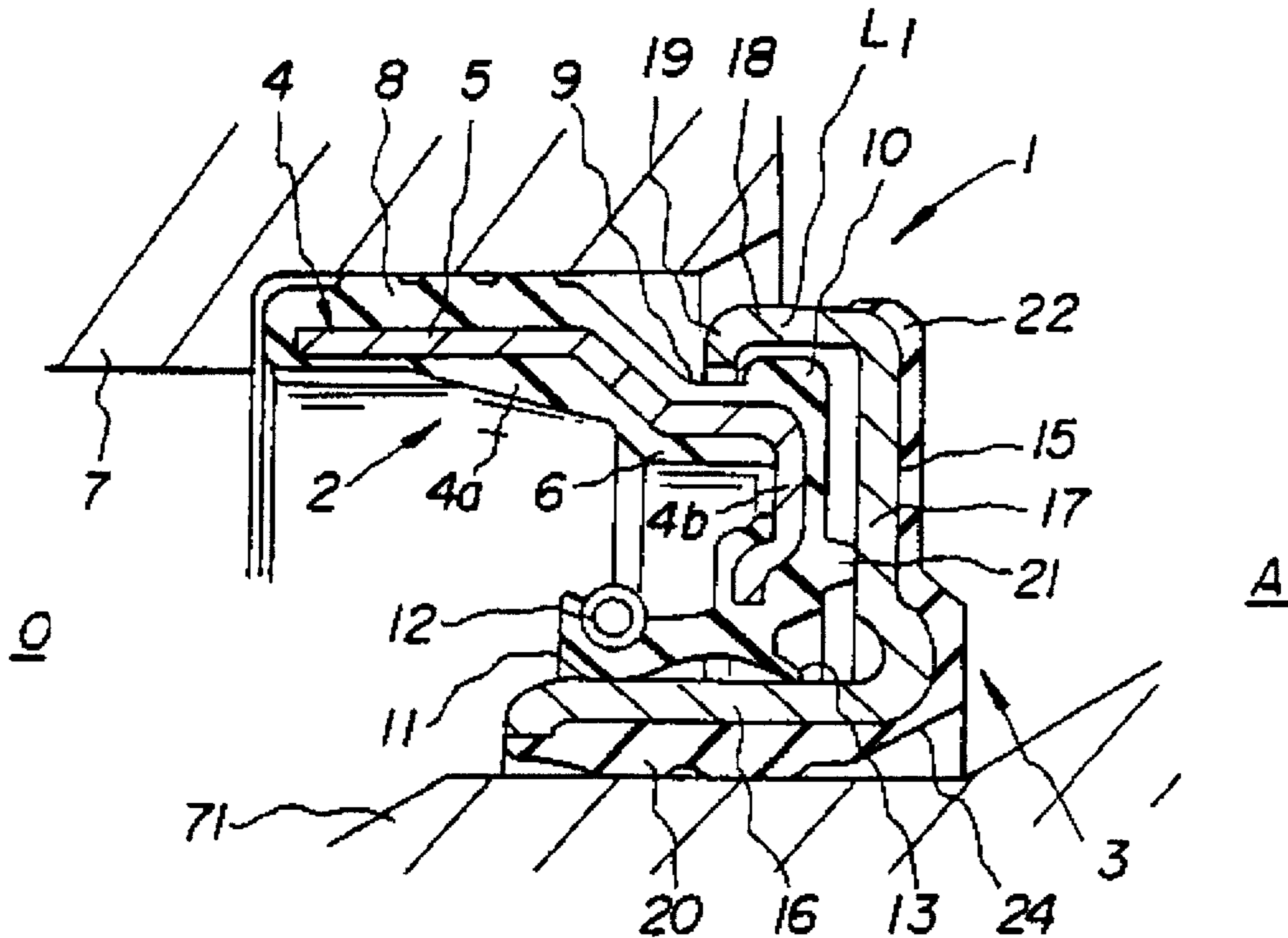


FIG. 1

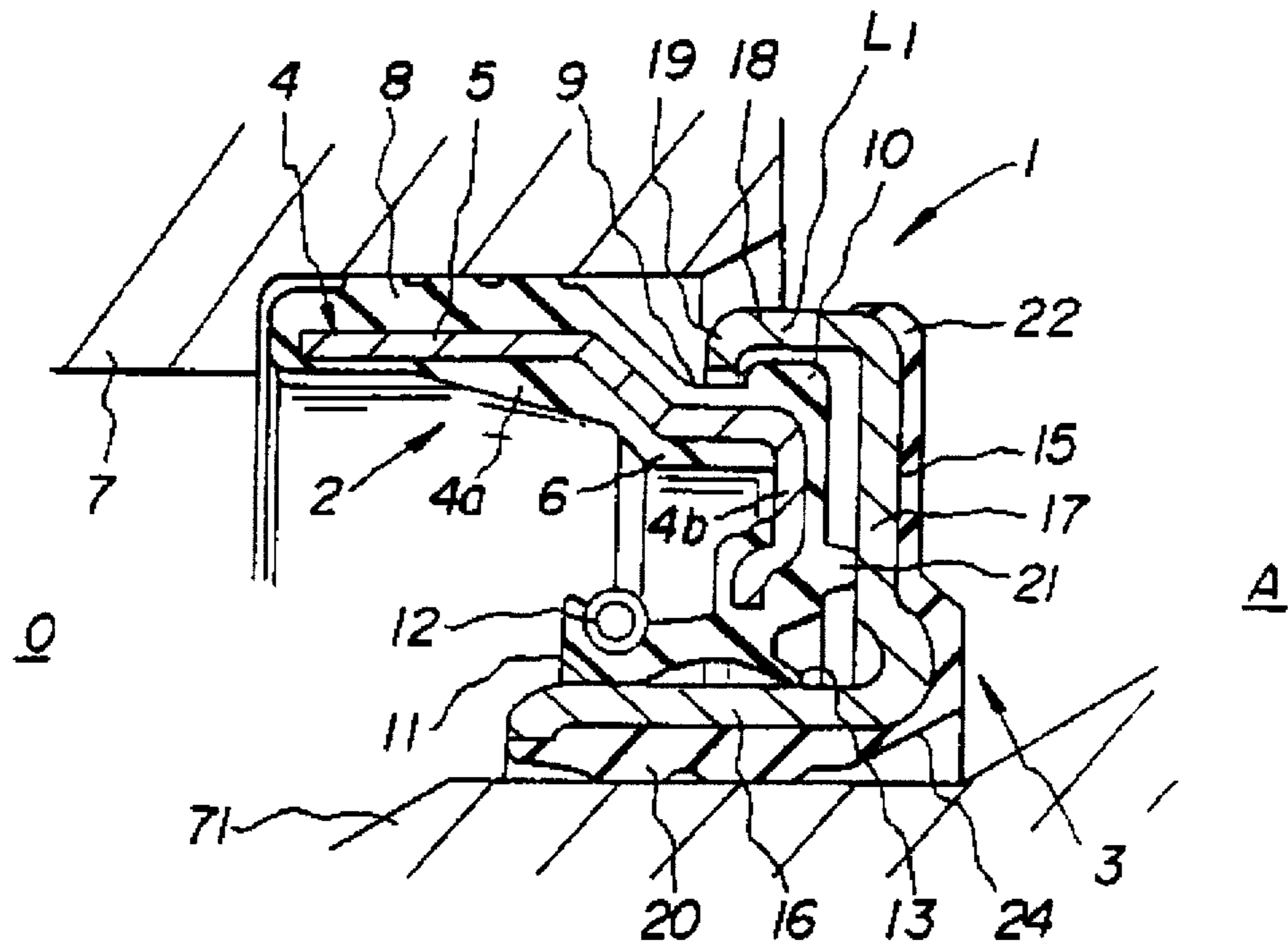


FIG. 2

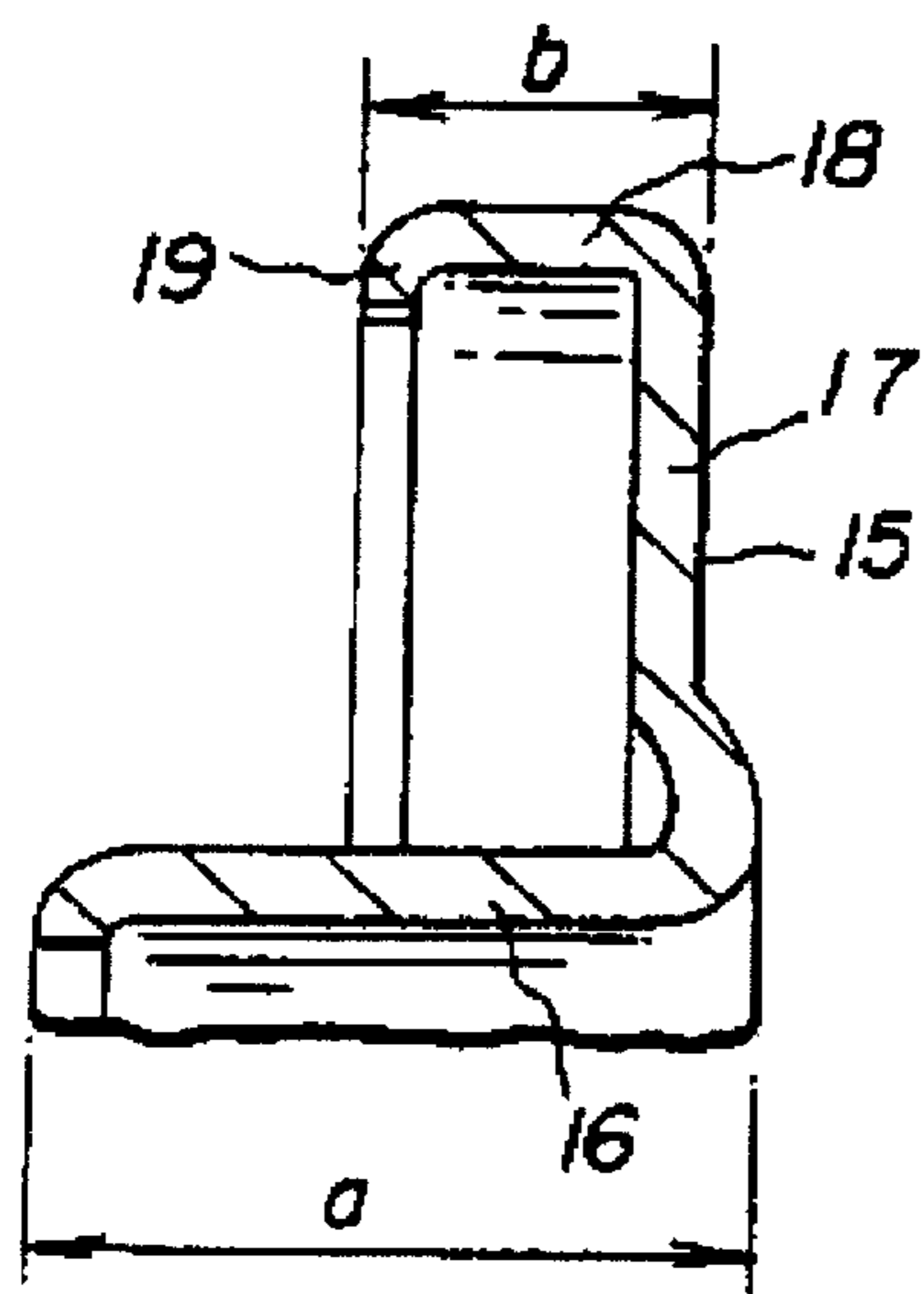


FIG. 3

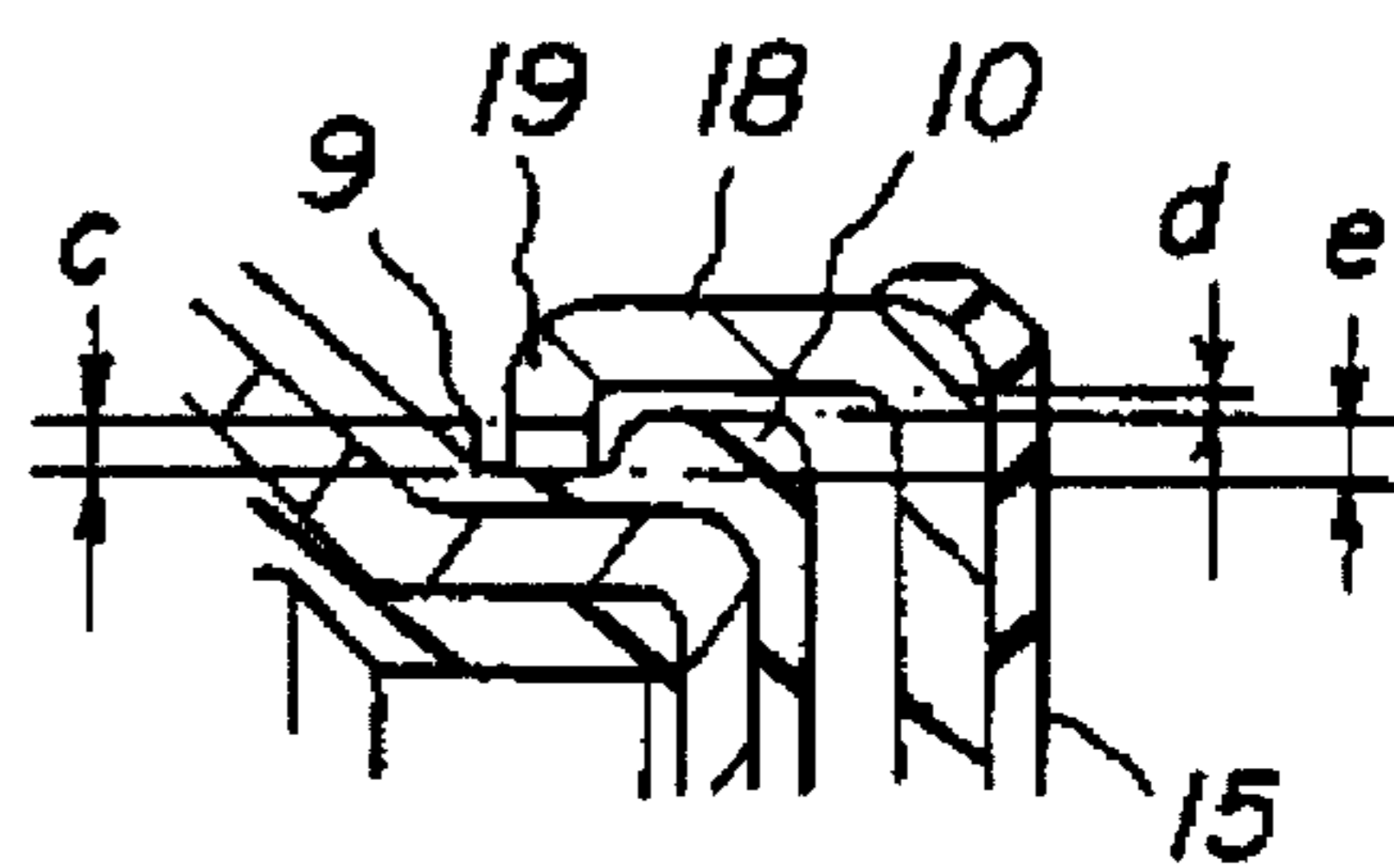


FIG. 4

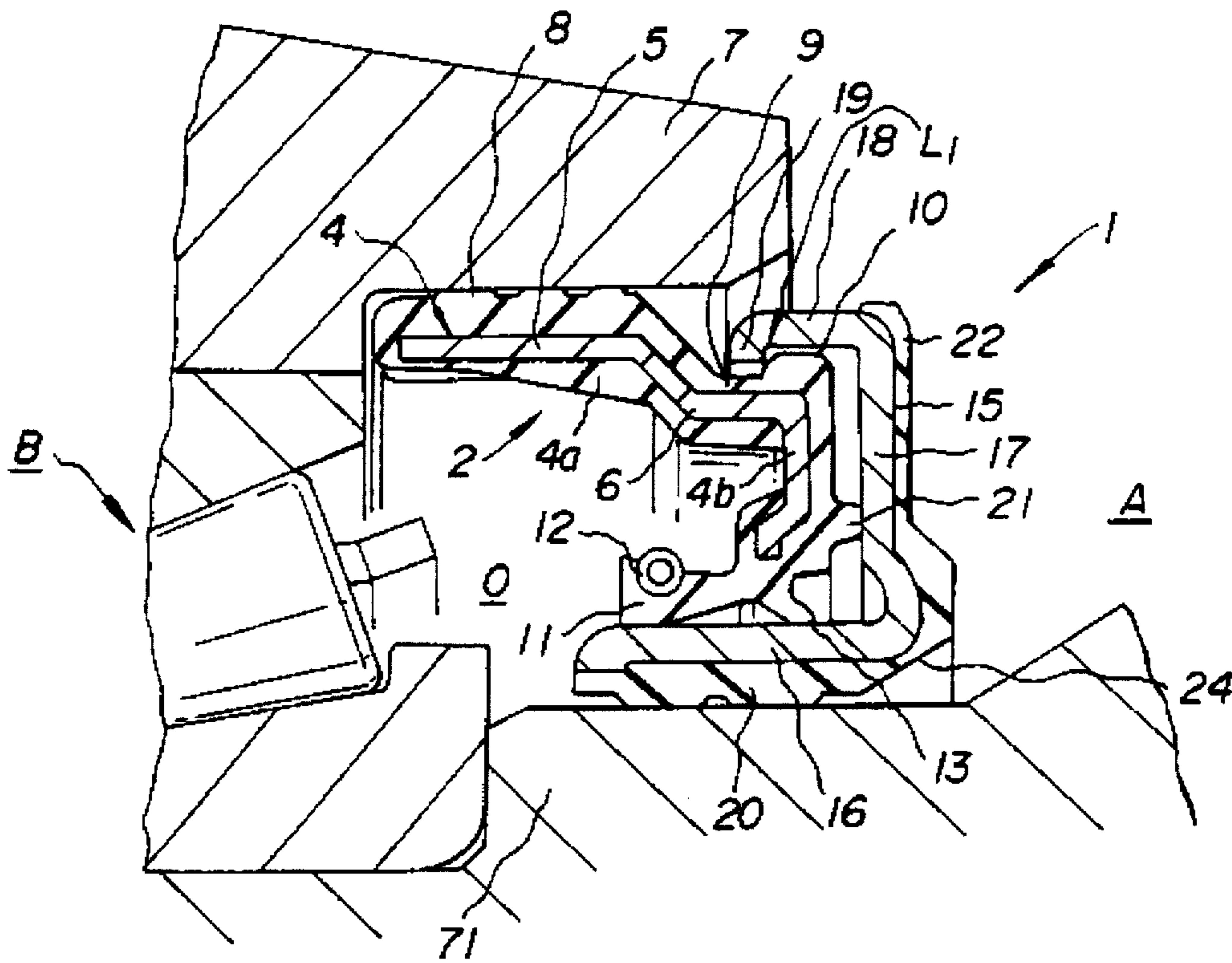


FIG. 5

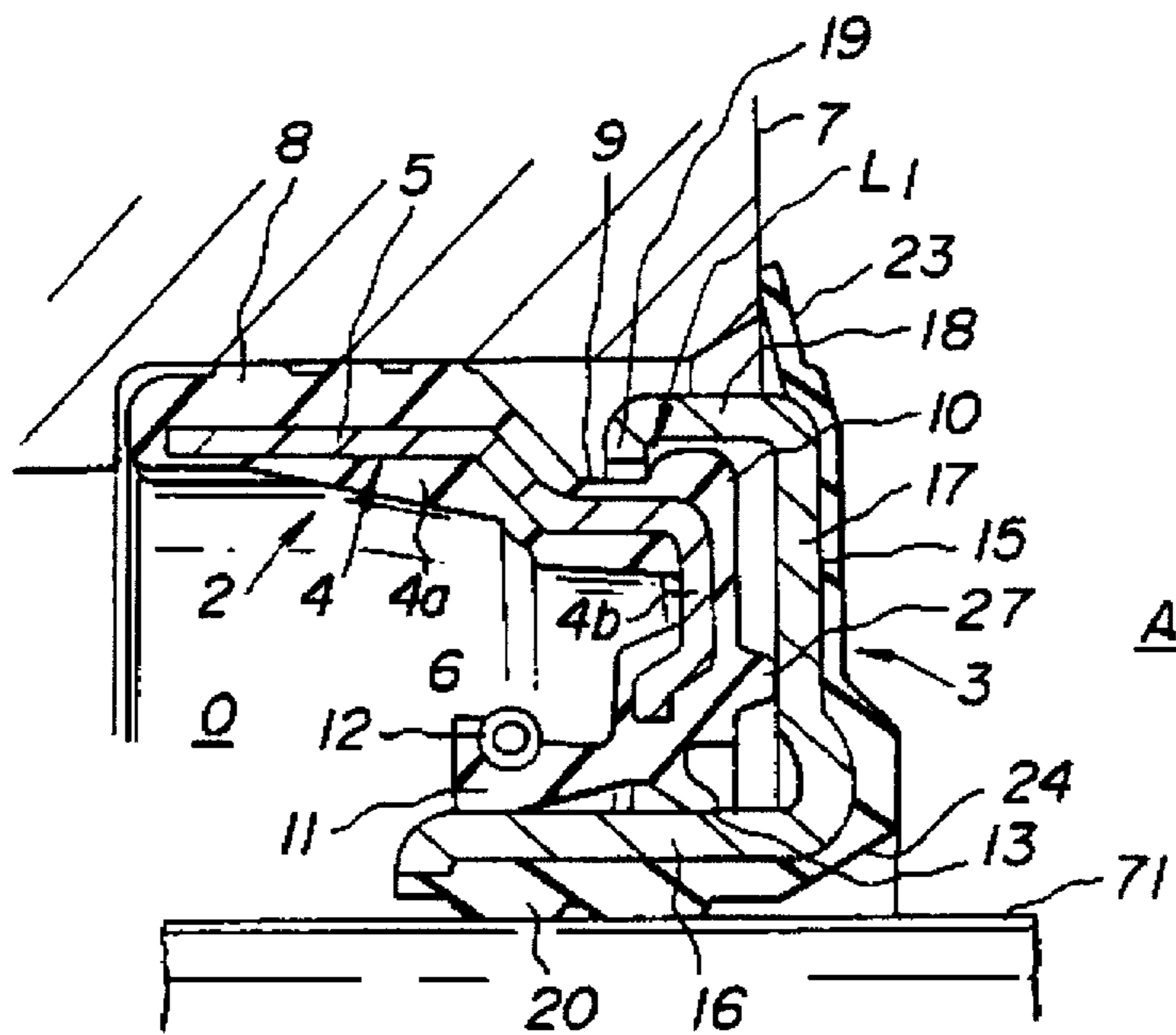


FIG. 6

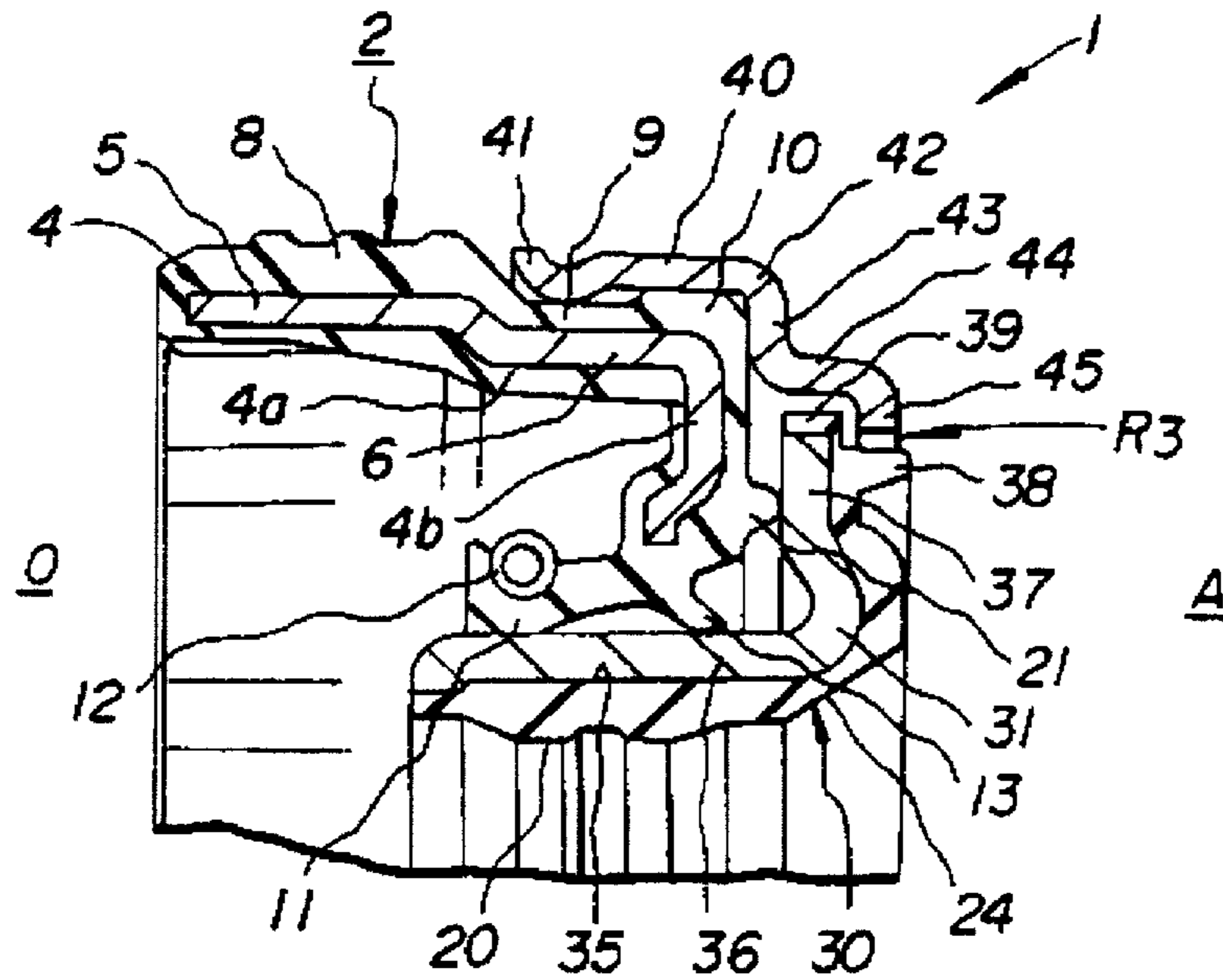


FIG. 7

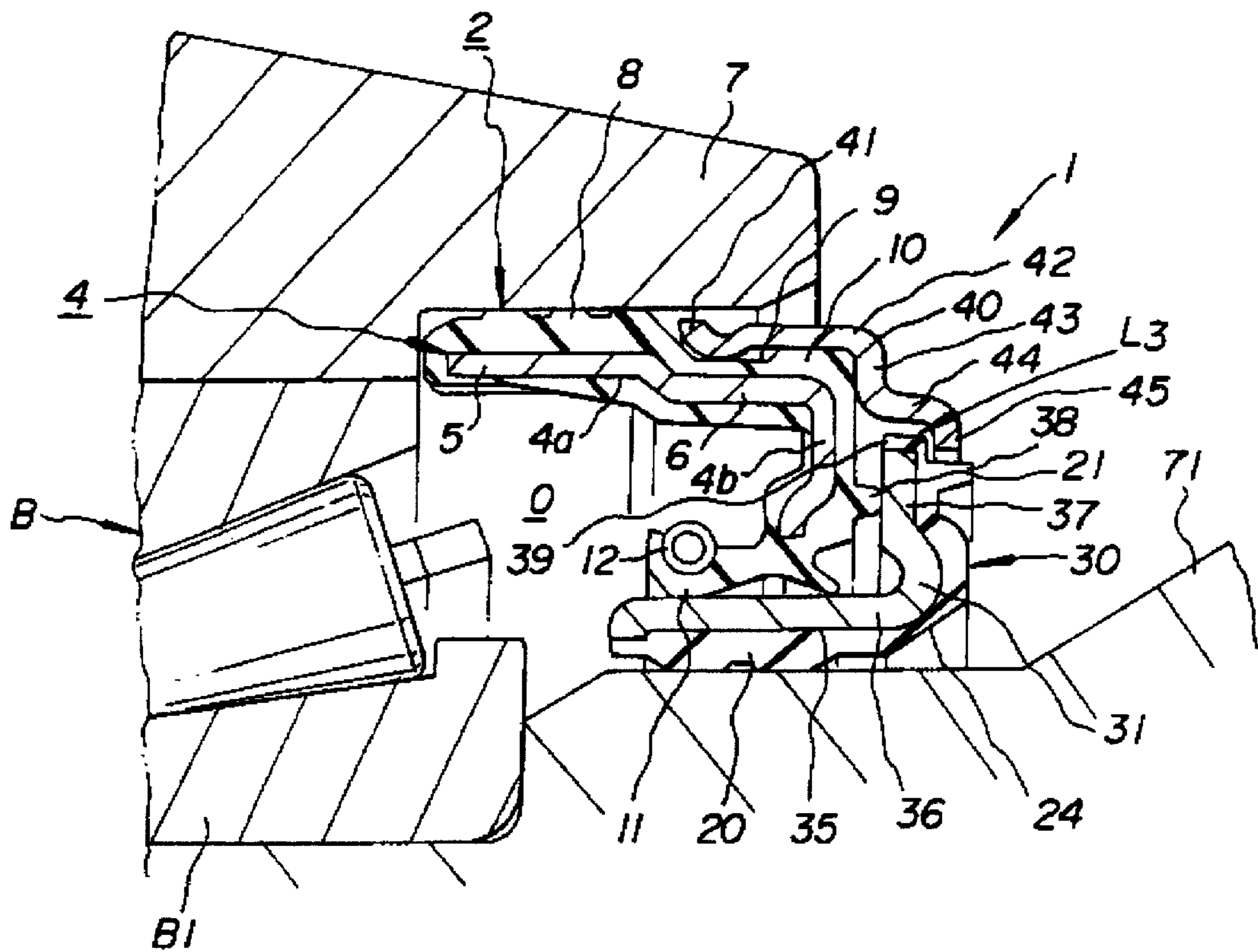


FIG. 8(a)

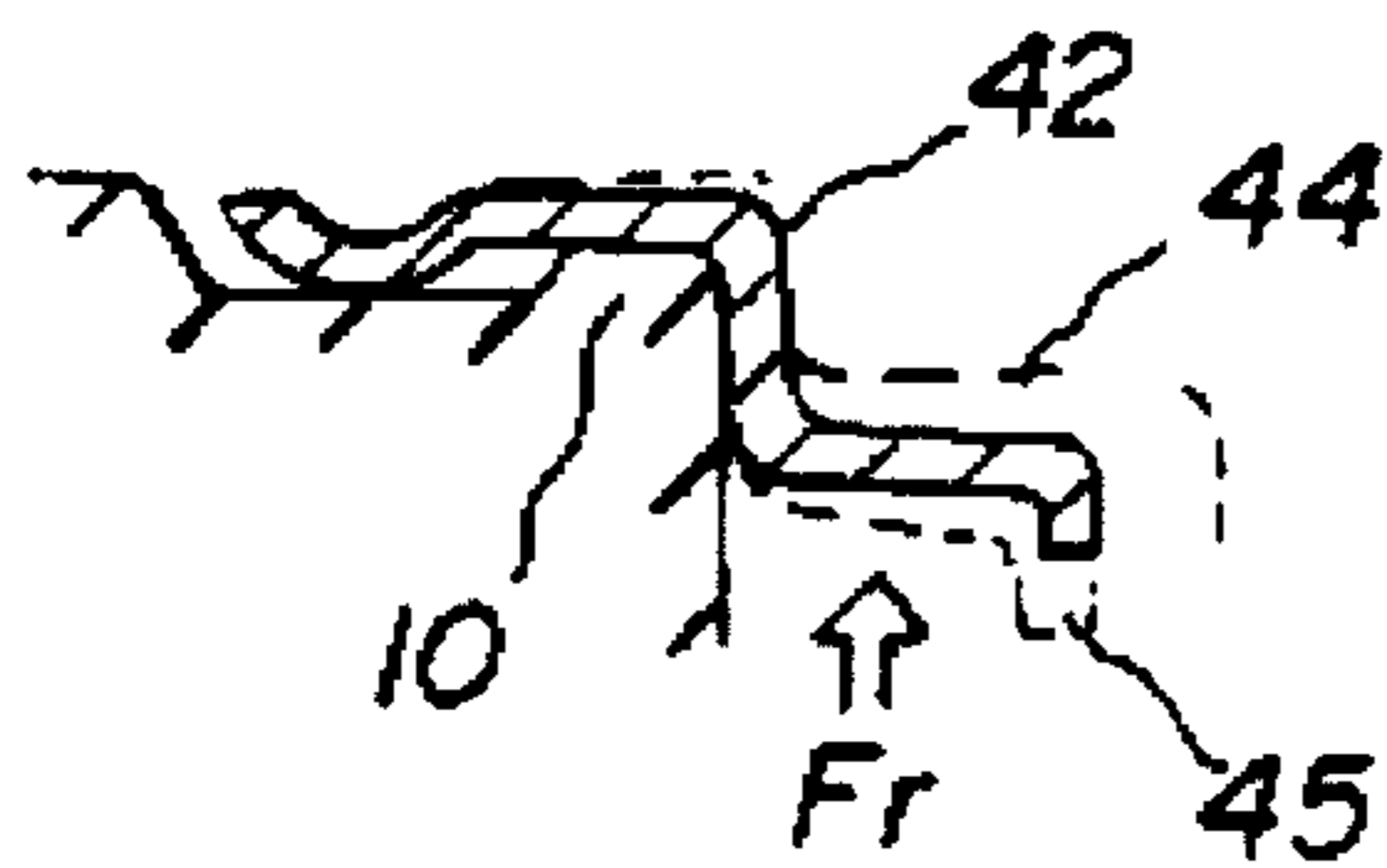


FIG. 8(b)

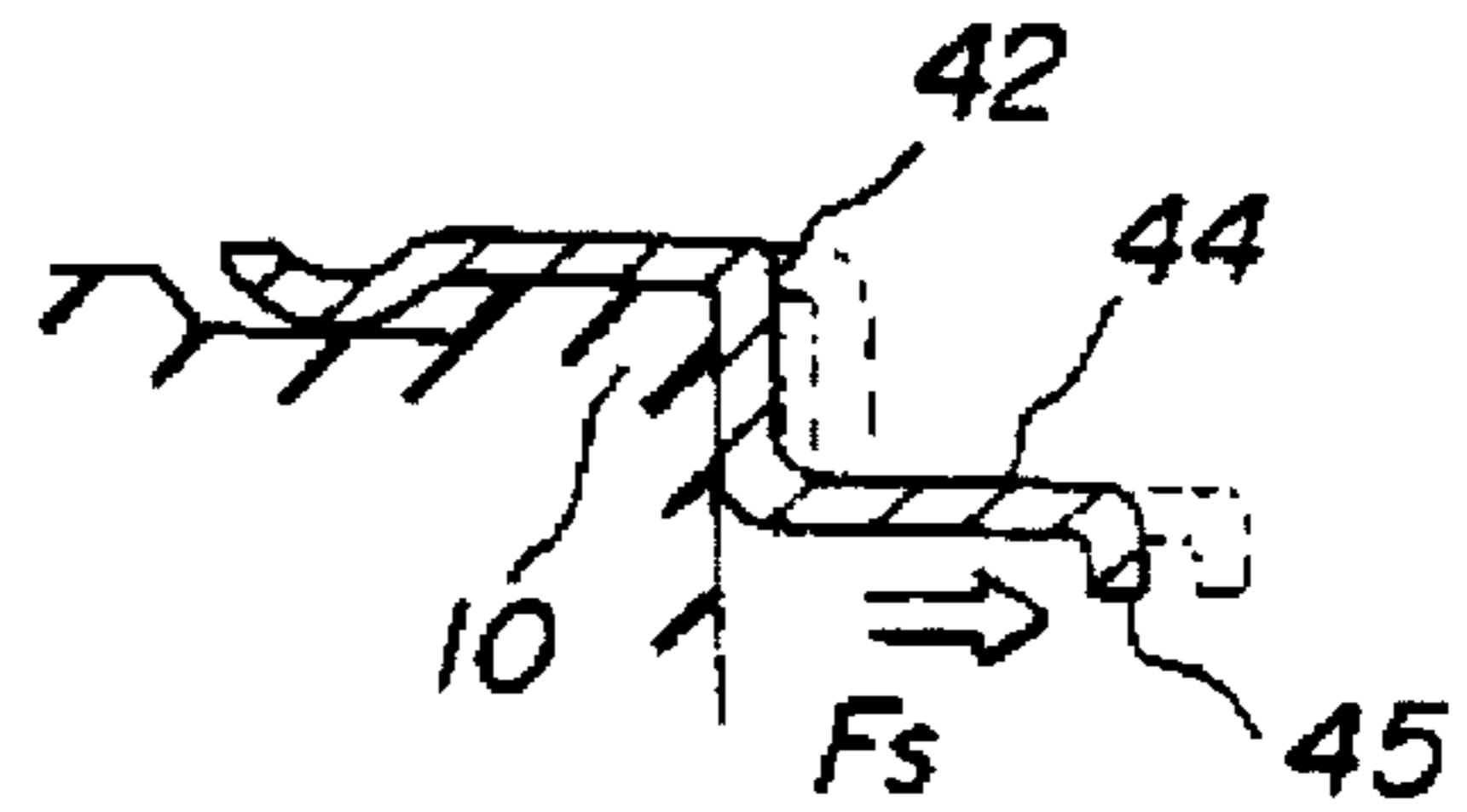


FIG. 9

PRIOR ART

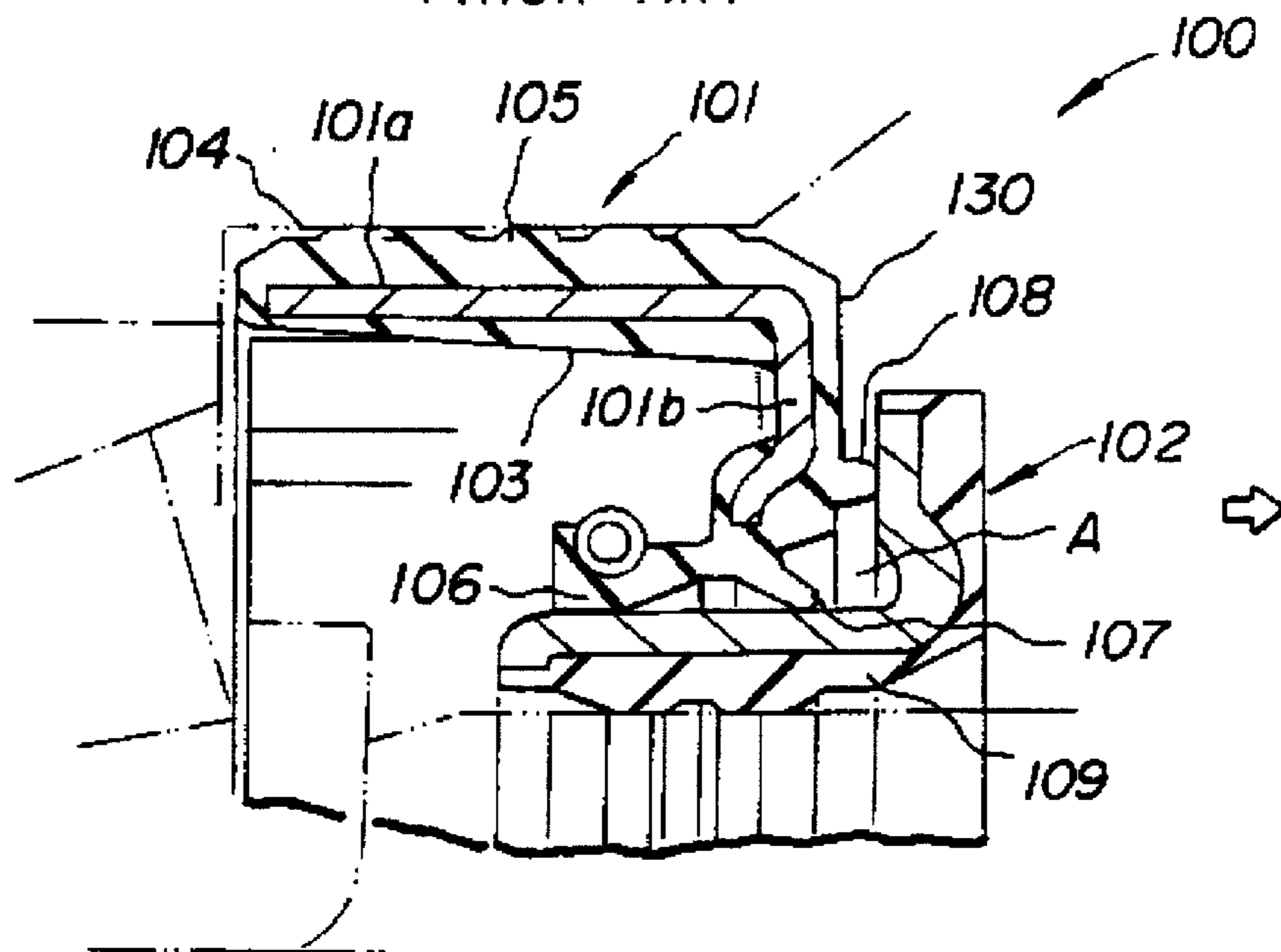


FIG. 10

PRIOR ART

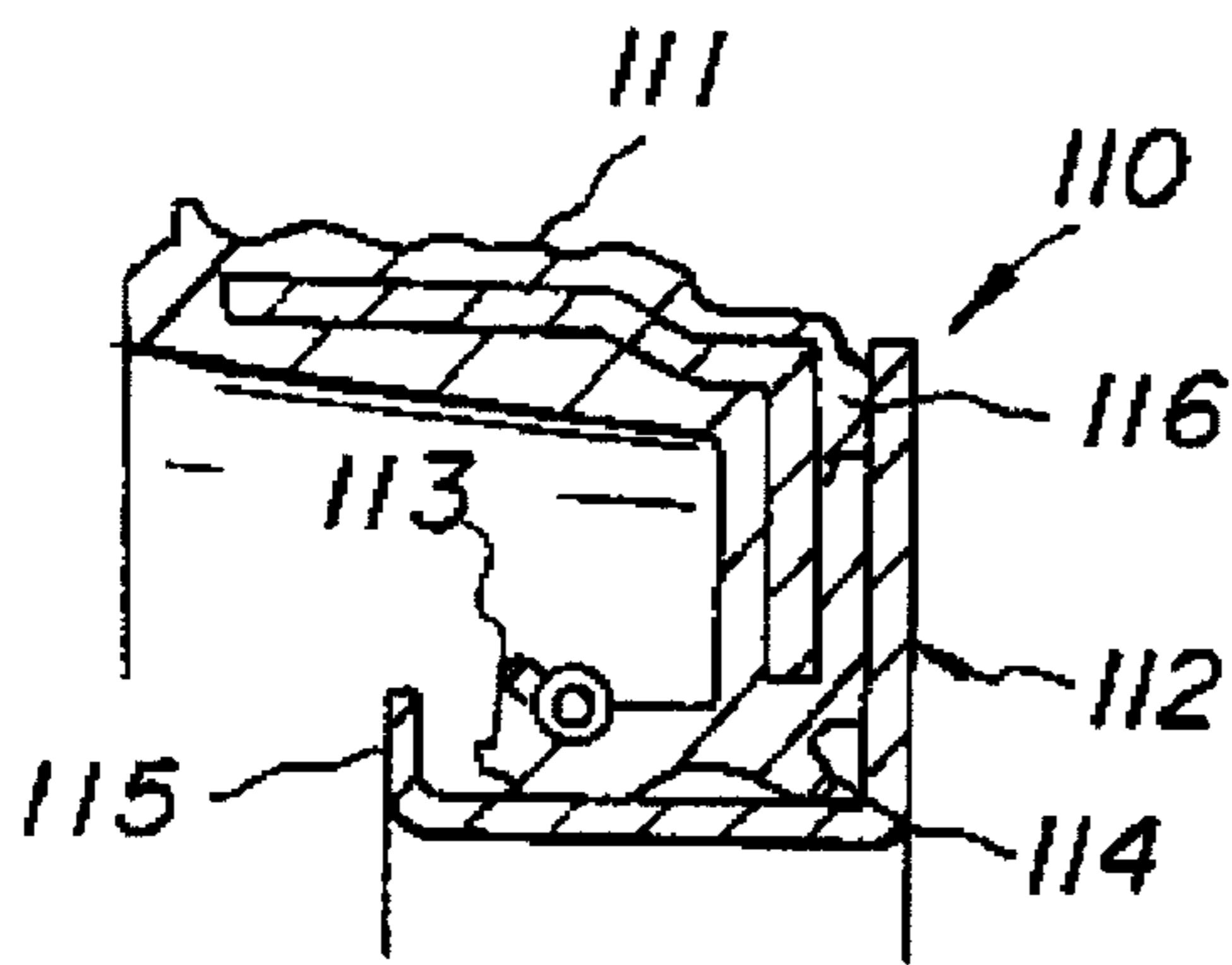


FIG. 11

PRIOR ART

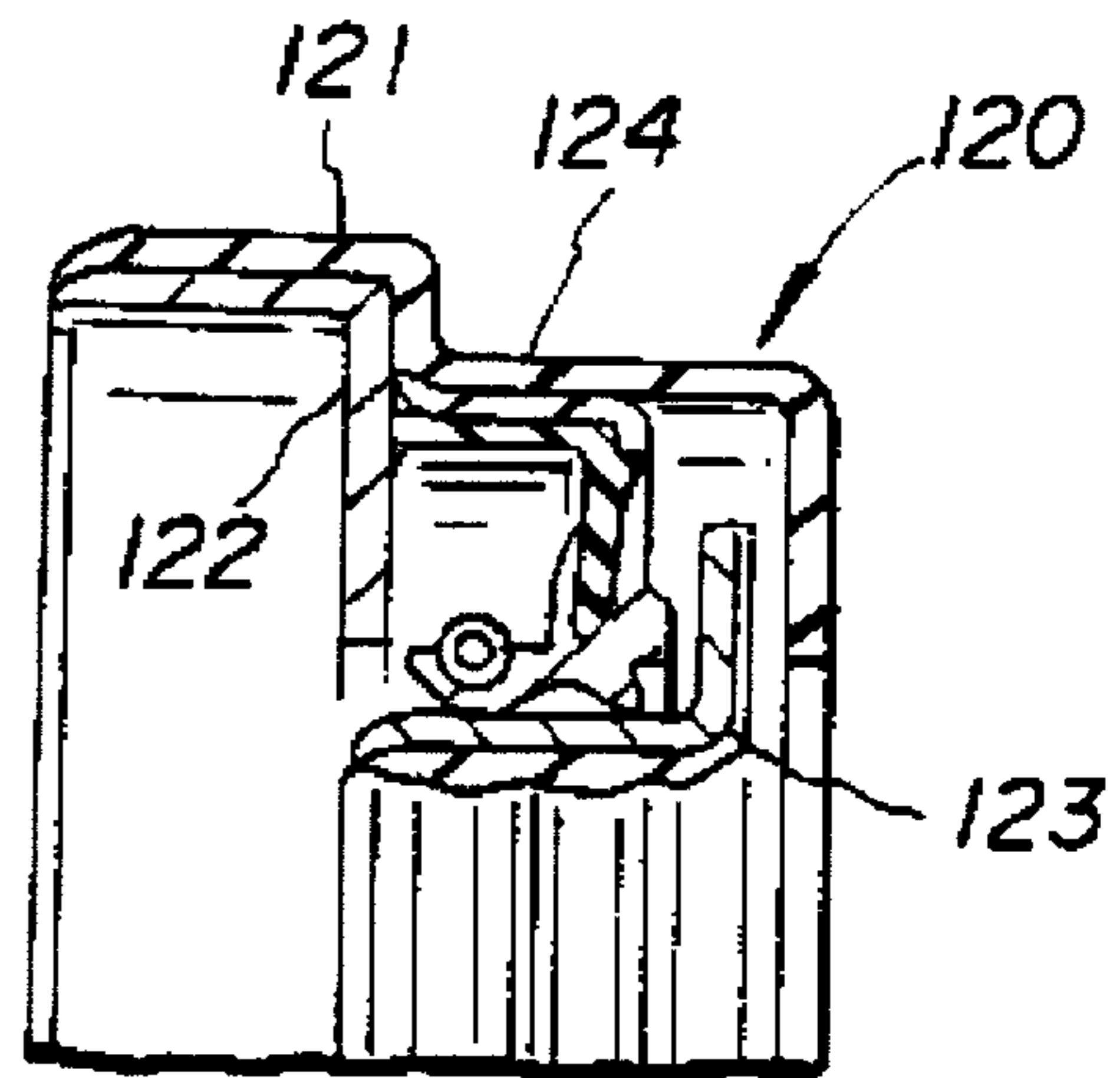
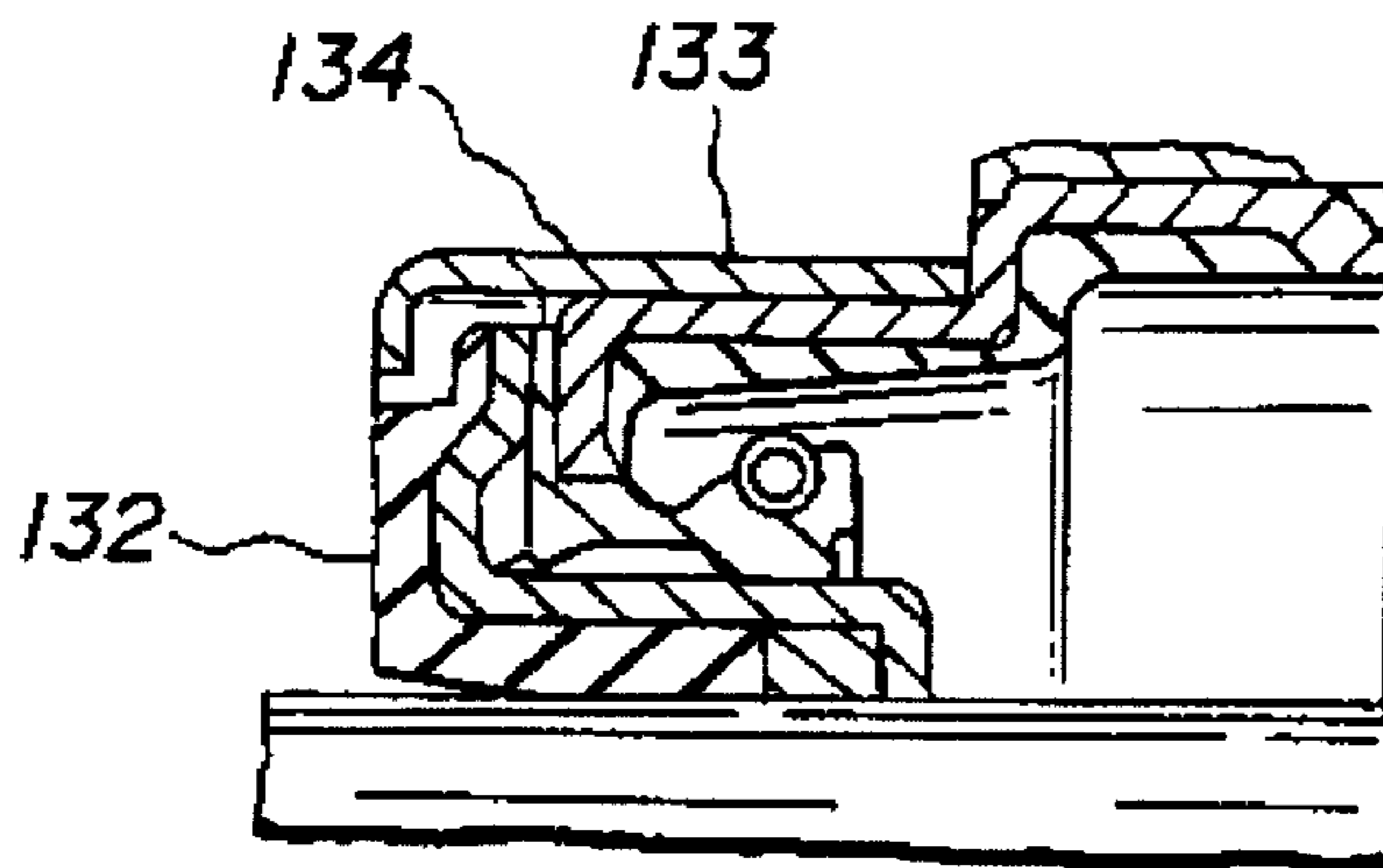


FIG. 12

PRIOR ART



SEALING DEVICE

Matter enclosed in heavy brackets [] appears in the original patent but forms no part of this reissue specification; matter printed in italics indicates the additions made by reissue.

This application is a continuation of application Ser. No. 08/066,936 filed May 25, 1993, now abandoned which is a continuation of application Ser. No. 07/855,058, filed Mar. 19, 1992, now abandoned which is a reissue application of U.S. Pat. No. 4,981,303, issued on Jan. 1, 1991.

BACKGROUND OF THE INVENTION

1. Field of the Invention

This invention relates to a sealing device for sealing two members which are relatively rotating, and more particularly to a sealing device which is unitized.

2. Description of the Related Art

One sealing device **100** such as shown in FIG. 9 is conventionally available. The sealing device **100** comprises a seal member **101** to be mounted onto a housing **104** and a sleeve member **102** to be mounted onto a shaft. The seal member **101** is provided with a metal ring **103** made up of a cylindrical portion **101a** and an inwardly directed flange **101b**. This metal ring **103** is provided with baked and molded rubber-like elastic members on both sides of the peripheral thereof, and has a rubber portion **105** which is fitted into the inner peripheral of the housing **104**.

From the inwardly directed flange portion **101b**, a seal lip **106** is extended such that the seal lip **106** slidably contacts the outer peripheral of the sleeve member **102** to seal a sealing liquid.

The seal lip **106** is provided with a dust lip **107** on the atmosphere side thereof to prevent entry of dust in the atmosphere into the device.

The inwardly directed flange **101 b** is further provided with a seal end projection **108** which is in contact with the sleeve member **102** to bring the inwardly directed flange **101b** into contact with the sleeve member **102**.

The inner peripheral of the sleeve member **102** is provided with a fitted portion **109** made of a rubber-like elastic member which is in contact with the shaft.

A second example of the conventional sealing device will be shown in FIG. 10. This sealing device **110** also comprises a seal member **111** and a sleeve member **112**. The seal member **111** is provided with a seal lip **113**, a dust lip **114**, and a seal end portion **116** which is in contact with an end surface of the sleeve member **112**. Reference numeral **115** designates a bend portion formed by bending the end portion of the sleeve member **112**.

Further, a third example of the conventional sealing device will be shown in FIG. 11. This sealing device **120** consists of four (4) components. That is, the device **120** comprises an outer ring **121**, and an inner ring **122**, and the assembly of a seal member **124** and a sleeve member **123** is contained within the outer ring **121** and the inner ring **122**.

As shown in FIG. 12 as a fourth example, an integrated type sealing device is known, in which a protection ring **133** is fitted into the outer peripheral of a seal member **134** and covers the opening formed between the seal member **134** and a sleeve member **132** (U.S. Pat. No. 4,448,426).

However, in the first example, of the conventional sealing device **100**, the seal member **101** and the sleeve member **102** are not integrated and thus are mutually separable. When the

bearing plays, or the shaft move in the direction of the arrow in FIG. 9 during its repair or overhaul causing a clearance to be formed between the projection **108** of the seal end surface and the sleeve member **102**. The device as a result easily admits dust and sludge into an internal space. This causes the dust lip **107** and the seal **106** to be worn in a short period of time, thereby impairing the durability of the device.

The opening provided between an end surface **130** on the atmosphere side of the seal member and the sleeve member **102** allows external dust, sludge or the like to directly reach the projection **108**. This causes not only the sliding portion to be worn in a short period of time but also a clearance to be formed, thereby allowing further entry. Moreover, the detachable construction of the device may additionally require careful handling so as not to damage the lip portion of the seal lip **106**.

In the second example of the conventional sealing device **110**, which is the example of a unitized device consisting of two components, the assembling operation requires the insertion of the sleeve member **112** into the seal member **111** and bending of an end portion **115** of the sleeve member **112**. Accordingly, the problems exist in the bending operation of the end portion **115** of the sleeve member **112** which is an additional process in assembling and in the construction which is subject to entry of dust as is the case with the first sealing device **100**.

In the third example of the conventional sealing device **120**, the number of components reaches as many as four (4), thereby not only complicating the assembling process but also increasing the cost.

In the fourth example of the sealing device which is of the integral structure and in which the opening is covered, the protection ring **133** is fixed. This not only causes the shaft to be either eccentrically rotated or eccentrically mounted during mounting operation but also causes the protection ring **133** to interfere with the rotating sleeve member **132** with an axially applied thrust. As a result, the rubber material deteriorates due to exposure to excessive heat and its life is significantly reduced.

To avoid such problems, a large clearance is given between the two members **133**, **132**. This large clearance, however, impairs the sealing performance against dust and sludge entering from outside.

SUMMARY OF THE INVENTION

This invention has been made in view of the above problems and has as an object the improvement of the sealing performance, particularly, against dust.

Another object of this invention is to reduce the cost and simplify the assembling process by decreasing the number of components.

Still another object of this invention is to improve the durability by controlling deformation, breakage, or excessive heat generation of the relatively moving members when they are in contact.

According to this invention, the above objects can be achieved by a sealing device comprising a seal member having a seal lip for sealing a sealed liquid in slidable contact with a sleeve member, and a dust lip for preventing entry of dust from the atmosphere side thereof. The sleeve member comprises a flange portion protruding so as to face the atmosphere side of the seal member. The seal member is provided with a projected portion having a rubber-like elastic member on the outer peripheral thereof, while the

3

flange portion of the sleeve member is provided with an outer cylindrical portion for covering an opening formed between the flange portion and the end portion on the atmosphere side of the seal member and for being covered by the projected portion of the outer peripheral of the seal member through a small clearance. The tip of the outer cylindrical portion is provided with a bend portion which is bent so as to axially overlap through the projected portion and the small clearance, or the projected portion is fixedly fitted into a protection ring for covering an opening formed between the end portion on the atmosphere side of the seal member and the flange portion of the sleeve member. The free end portion of the protection ring is extended to the atmosphere side of the flange portion and mounted so as to axially overlap through the outer end of the flange portion and a small clearance.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a longitudinal sectional view of the main portion of a sealing device which is a first embodiment of the invention; FIG. 2 is a longitudinal sectional view of the main portion of the metal ring provided on the sleeve member of the device shown in FIG. 1; FIG. 3 is fragmentary longitudinal sectional view of the labyrinth portion shown in FIG. 1; FIG. 4 is a longitudinal sectional view of the main portion of the device shown in FIG. 1 with a bearing mounted thereto; FIG. 5 is a longitudinal sectional view of the main portion of a sealing device which is a second embodiment of the invention; FIG. 6 is a longitudinal sectional view of the main portion of a sealing device which is a third embodiment of the invention; FIG. 7 is a longitudinal sectional view of the main portion showing the mounting of the device shown in FIG. 6; FIG. 8 is an explanatory diagram showing the operation of the protection ring of the device shown in FIG. 6; (a) is a longitudinal sectional view of the main portion thereof when the radial force F_r is applied thereto; (b) is a longitudinal sectional view of the main portion thereof when the thrust force F_s is applied thereto; and FIGS. 9 through 12 are longitudinal sectional views of the main portions of the conventional sealing devices, respectively.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

This invention will be described in detail with reference to the drawings.

FIG. 1 shows a sealing device which is a first embodiment of the invention. The sealing device 1 for sealing a shaft 71 as an inner member and a housing 7 as an outer member, both being mounted so as to be concentrically and relatively rotatable, comprises a seal member 2 to be mounted onto the housing 7 and a sleeve member 3 to be mounted onto the shaft 71.

The seal member 2 has a metal ring 4, the metal ring 4 comprises an outer cylindrical portion 4a and an inwardly directed flange 4b, while an outer cylindrical portion 4a comprising a greater diameter portion 5 and a smaller diameter portion 6. The seal member 2 is further formed with a rubber portion 8 which is fitted into the mating housing 7, and a recessed portion 9 and a projected portion 10, both provided on the outer peripheral portion of the smaller diameter portion 6. *The recessed portion 9 is formed on the outer surface of the seal member 2; and the projected portion 10 outwardly protrudes in a radius direction from a bottom portion of the recessed portion 9.*

4

On the other hand, an end portion of the bore of the inwardly directed flange 4b of the metal ring 4 is provided with a seal lip 11, and a garter spring 12 is mounted to the outer peripheral of the seal lip 11 to apply a torque to the seal lip 11.

The seal member 2 is further provided with a dust lip 13 for preventing entry of dust on the atmosphere side A of the seal lip 11. The seal lip 11 and the dust lip 13 are in slidable contact with the outer peripheral portion of the sleeve member 3. The sleeve member 3 is made up of a U-shaped metal ring 15, the U-shaped metal ring 15 being composed of an inner cylindrical portion 16 which extends in parallel to an outer peripheral cylindrical portion 4a of the metal ring 4 of the seal member 2, a flange portion 17 which radially protrudes in the outward direction from the end peripheral on the atmosphere side, and an outer cylindrical portion 18 which extends toward a sealed liquid O to be axially sealed from the tip of the flange portion 17. This outer cylindrical portion 18 not only covers an opening formed on the outer diameter side between the end surface on the atmosphere side of the seal member 2 and the flange portion 17 but also [is covered by] covers a projected portion 10 provided on the smaller diameter portion 6 of the seal member 2 through a small clearance L1, while a bend portion 19 at the tip thereof is inserted into the recessed portion 9 through the small clearance. *The small clearance L1 is, as shown in FIG. 1, a substantially S-shaped channel.* The bend portion 19 is disposed so as to axially overlap the recessed portion 10 and integrally assemble the seal member 2 and the sleeve member 3.

A rubber-like elastic member 20 is attached by baking to the inner peripheral of the inner cylindrical portion 16 of this U-shaped metal ring 15 so that the U-shaped metal ring 15 is fitted to the relatively rotatable shaft 71 under a fluid dense condition. The rubber-like elastic member 20 has a guide taper 24, the guide taper 24 serving as a guide in mounting the sealing device 1 in a predetermined location. The lateral surface on the atmosphere side of the flange portion 17 is also covered by a rubber-like elastic member 22. On the other hand, the end surface on the atmosphere side of the seal member 2 is provided with an annular projection 21 which comes in contact with the flange portion 17 of the sleeve member 3.

FIG. 2 shows the U-shaped metal ring 15. If it is supposed that the length of the inner cylindrical portion 16 is a and that of the outer cylindrical portion 18 is b, the U-shaped metal ring 15 is arranged so that there is a relationship such as $a > b$. FIG. 3 shows an enlarged view of a part of FIG. 1. Here, it is supposed that the clearance between the bend portion 19 at the tip of the U-shaped metal ring 15 is c and the clearance between the recessed portion 9 and the projected portion 10 is e. It is further supposed that the clearance between the inner peripheral of the outer cylindrical portion 18 of the U-shaped metal ring 15 and the projected portion 10 is d. Then, there are such relationships as $d > 0$ and $e > c$, and the tip portion is radially bent so that $c > 0$. The seal member 2 and the sleeve member 3 are unitized in this way.

Thus, the sealing device 1 unitizes the seal member 2 and the sleeve member 3, but permits a certain amount of eccentricity.

The arrangement in which the seal member 2 is slightly distanced from the sleeve member 3 could form a labyrinth seal L1 by the clearances formed between the outer cylindrical portion 18 of the U-shaped metal ring 15 and the bend portion 19, and recessed portion 9 and projected portion [1] 10, thereby improving the sealing performance against dust.

5

FIG. 4 shows an example in which the sealing device 1 in the above embodiment is mounted together with a bearing B.

In this example, by using the U-shaped sleeve member 3 which allows the seal member to be unitized, it is possible not only to reduce the cost with reduced number of components but also to simplify the assembling process of the sealing device 1 allowing manual assembly.

Further, the sleeve member 3 is constructed as a slinger, so that the entry of external dust and splashes of sludge can be prevented, thereby significantly improving the sealing performance against dust.

Furthermore, the outer cylindrical portion of the sleeve member and the projected portion on the outer peripheral of the seal member serve as a labyrinth seal, thereby significantly improving the sealing performance against dust.

FIG. 5 shows a second embodiment of the sealing device according to the invention. Parts and components which have the same functions as in the first embodiment will be referred to as the same reference numerals. In the second embodiment, the tip of a flange portion 7 of a sleeve member 3 is provided with an auxiliary dust lip 23 which is in hermetic contact with an end surface of a housing 7, whereby sealing performance against dust and sludge are far better than the first embodiment. The description of other constructions and operations will be omitted since they are the same as in the first embodiment.

FIG. 6 shows a third embodiment of the invention. Similarly in this embodiment, parts and components which have the same functions as in the first embodiment will be referred to as the same reference numerals.

In the third embodiment, a sleeve member 3 comprises a metal ring 35 whose section is substantially L-shaped, having an inner cylindrical portion 36 and a flange portion 37. There is provided no outer cylindrical portion 18 such as in the first embodiment. Instead, there is a protection ring 40 to cover an opening formed between the sleeve member 30 and the flange portion 37. The protection ring 40 is fitted into the outer peripheral of a recessed portion 9 and a projected portion 10 of the seal member 2.

An outer end portion 41 of the protection ring 40 is bent, and a bend portion 42 radially extends so as to surround the projected portion 10 and an end surface portion 43, and further an extended portion 44 which axially extends from the end surface portion 43.

The bending position at the boundary between the inner cylindrical portion 36 of the sleeve member 30 and the flange portion 37 are provided with a bend portion 31 which is bent so as to be projected toward the atmosphere side A.

From the extended portion 44, an end portion 45 which is bent to keep a small clearance with respect to a flange end 39 and a stepped lip 38 is provided. An end portion 45 is formed so as to cover the flange end [37] 39. Thus, the protection ring 40 is provided on the recessed portion 9 and projected portion 10 by the outer end portion 41 so as to move in an axial direction. It is also provided with the end portion 45 of the flange end [37] 39 which is bent so that it is provided with a small clearance relative to the stepped lip 38. Accordingly, the protection ring 40 can oscillate if a radial or axial load is applied thereto.

Also a labyrinth R3 is formed between the extended portion 44 and the end portion 41 of the protection ring 40, and between the flange end [37] 39 and the lip 38. The labyrinth R3 is, as shown in FIG. 6, a substantially S-shaped channel.

The mounting condition of the sealing device thus constructed is shown in FIG. 7. As is clear from the figure, the

6

sealing device 1 and the protection ring 40 are press-fitted. Then, a shaft 71 is inserted along the bore of an inner race B1 of a bearing B to be press-fitted into the inner peripheral of the sleeve member 30. Such a construction allows either the housing 7 or the shaft 71 to rotate. In this way, the unitized seal type sealing device in which the sleeve member 30 and the seal member 2 are unitized eliminates the need for the control of surface conditions of the shaft 71 which influences the sealing performance of the seal, thereby allowing the shaft to be easily mounted. More specifically, the rubber-like elastic members provided on both sides of the peripheral are well fitted into both housing 7 and shaft 71, whereby the shaft can be mounted merely by means of manual compression. Further, the seal lip 11 is protected by the sleeve member 30, thereby providing the advantage in that lip damage, adhesion of dust and other foreign matters, and deterioration of the previously applied grease can be prevented.

On the other hand, the protection ring 40 is fixed at two points; that is, at the outer end portion 41 thereof on the rubber surface of the recessed portion 9 provided on the outer peripheral of the rubber portion 8 and at the increased thickness of the projected portion 10 of the rubber portion 8. This double fixing of the protection ring 40 serves to make proper adjustments so that the protection ring 40 does not become eccentric in a radial direction, does not move out in a thrust direction, is not subjected to friction due to excessive load, nor is it deformed or damaged due to contact should the shaft 71 be eccentrically rotated or mounted onto the housing 7, thrust movement be generated, and as a consequence, should an improper load be applied to the two members in relative rotation.

This will now be described with reference to the drawings. FIG. 8 (a) shows a state in which the eccentric rotation is readily adjustable by the contact between the flange end [37] 39 and the force F_r ; FIG. 8 (b) shows a state in which the protection ring 40 is movable by the contact between the flange end [37] 39 and the force F_s . Other arrangement and operation are the same as in the first embodiment, and therefore the description thereof will be omitted.

According to the third embodiment, in which the sealing device comprises the protection ring 40, one end of which is fitted into the seal member 2 on the stepped outer cylindrical portion 4a of the metal ring 4, while the other end thereof is provided with a small clearance with respect to the lip 38; and the protection ring 40 covers the opening into the atmosphere formed between the seal member 2 and the sleeve member 30. Therefore, it is possible to prevent entry of dust and splashes of sludge from outside, whereby the sealing performance against dust can be significantly improved.

Further, the extended portion 44 and end portion 43 of the protection ring 40, as well as the flange end [37] 39 and lip 38 provides the function of a labyrinth seal L3, thereby further improving the sealing performance against dust.

The protection ring 40 serves to function of making proper adjustments so that the protection ring 40 does not become eccentric in a radial direction, does not move out in a thrust direction, is not subjected to friction due to excessive load, nor is it deformed or damaged due to contact should the shaft 71 be eccentrically rotated or mounted onto the housing 7, thrust movement be generated, and as a consequence, should an improper load be applied to the two members in relative rotation. Thus, any deformation, damage, and generation of excessive heat due to sliding contact between the two members 2, 30 can be prevented, thereby providing a longstanding sealing performance.

What is claimed is:

1. A sealing device for sealing between concentric inner and outer members which are relatively rotatable with respect to one another, the sealing device comprising:

a seal member to be mounted onto the outer member, said seal member having a side facing outward towards the atmosphere, a seal lip for sealing a liquid in slidable contact with a sleeve member, an annular projected portion having a rubber-like elastic member on the outer periphery of said seal member, and an end portion on the atmosphere side of said seal member; and

a sleeve member to be mounted onto the inner member, said sleeve member having a flange portion protruding so as to face the atmosphere side of said seal member, and an outer cylindrical portion over-lapping with the projected portion of said seal member for covering an opening defined between the flange portion of said sleeve member and the end portion of said seal member,

the outer cylindrical portion of said sleeve member having a [lip] tip with a bend portion of axially over-lapping and inter-engaging with the projected portion of said seal member.

2. The sealing device according to claim 1, wherein said seal member is provided with a ring-shaped projection for slidably contacting said sleeve member on said atmosphere side thereof.

3. The sealing device according to claim 2, wherein said outer cylindrical portion of said seal member to be mounted onto said outer member is stepped by a greater diameter portion and a smaller diameter portion, said small diameter portion being provided with a projected portion.

4. The sealing device according to claim 3, wherein said smaller diameter portion of the seal member is provided

with a recessed portion on the sealed liquid side of the projected portion.

5. A sealing device for sealing between concentric inner and outer members which are relatively rotatable with respect to one another, the sealing device comprising:

a seal member to be mounted onto said outer member, said seal member having a side facing radially outward towards the atmosphere, a recessed portion on said radially facing side of said seal member, an annular projected portion having a first rubber-like elastic member on said radially facing side of said seal member and protruding in a radial direction from a bottom portion of said recessed portion, a seal lip for sealing a liquid and an end portion on the atmosphere side of said seal member;

a sleeve member to be mounted onto said inner member, said sleeve member having an inner cylindrical portion, a flange portion protruding therefrom so as to face said end portion of said seal member and a second rubber-like elastic member covering at least an inner peripheral portion of said inner cylindrical portion, wherein said sleeve member slidably contacts with said seal lip of said seal member for sealing said liquid; and

an outer cylindrical member positioned over an opening formed between said flange portion of said sleeve member and said end portion of said seal member, said outer cylindrical member having a bend portion for forming a substantially narrow channel portion between said opening and the atmosphere, wherein an end portion of said outer cylindrical member extends into said recessed portion, whereby said outer cylindrical member is resiliently supported.

* * * * *