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Iwasaki et al.

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(54) **TRANSMISSION BRAKE DEVICE**

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(Continued)

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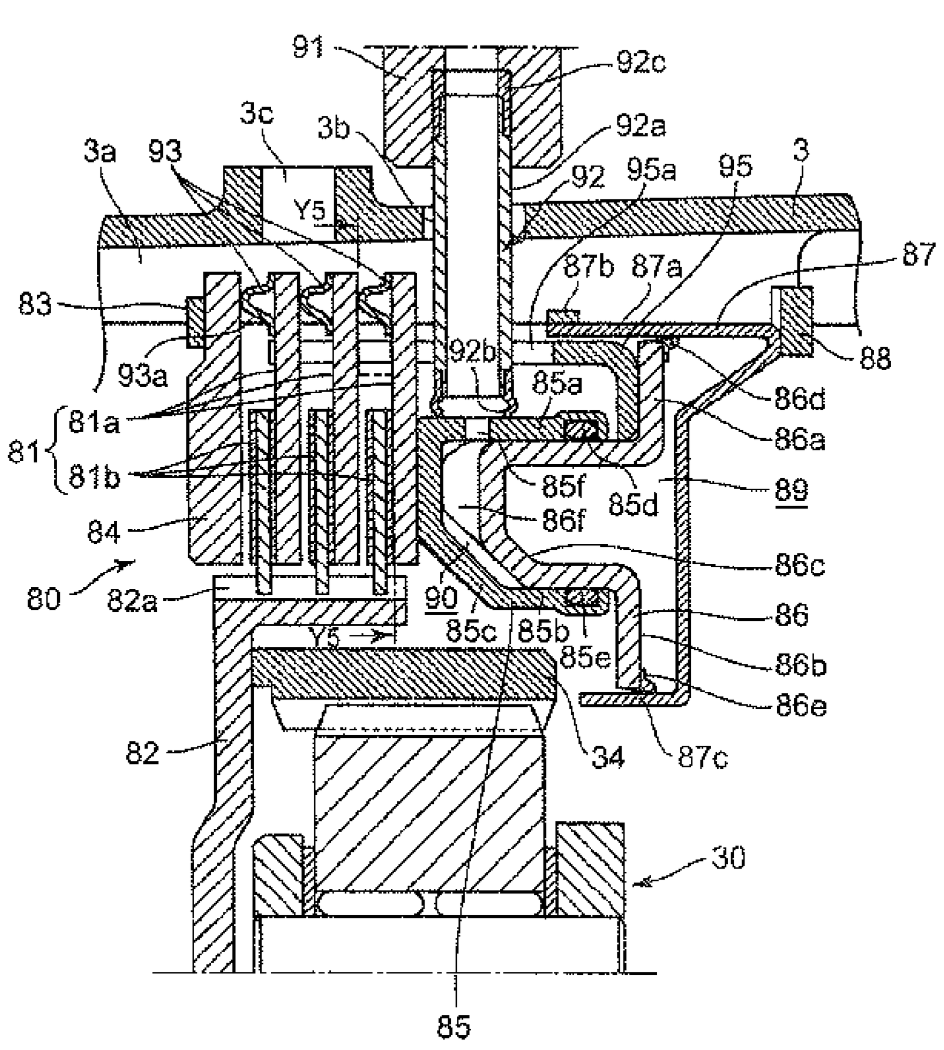
(74) *Attorney, Agent, or Firm* — Studebaker & Brackett PC

(57) **ABSTRACT**

A transmission brake device includes: a friction plate set configured such that a plurality of rotation-side friction plates; an engaging piston disposed on an axial side of the friction plate set; a clearance adjustment piston disposed on a side of the engaging piston opposite to the friction plate set; a clearance adjustment hydraulic chamber configured to move the clearance adjustment piston; and an engaging hydraulic chamber configured to move the engaging piston; a biasing member disposed between each adjacent pair of the fixed-side friction plates, the biasing member being configured to bias each adjacent pair of the fixed-side friction plates in directions away from each other. The biasing member distributes the clutch clearance in a gap between each adjacent pair of the fixed-side friction plates
(Continued)



when a hydraulic pressure is supplied only to the clearance adjustment hydraulic chamber.

2 Claims, 12 Drawing Sheets

(51) **Int. Cl.**

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B60T 1/06	(2006.01)
F16D 55/00	(2006.01)
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F16H 63/30	(2006.01)
F16H 57/10	(2006.01)
F16D 121/04	(2012.01)
F16H 3/66	(2006.01)

(52) **U.S. Cl.**
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(58) **Field of Classification Search**
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See application file for complete search history.

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FIG. 1

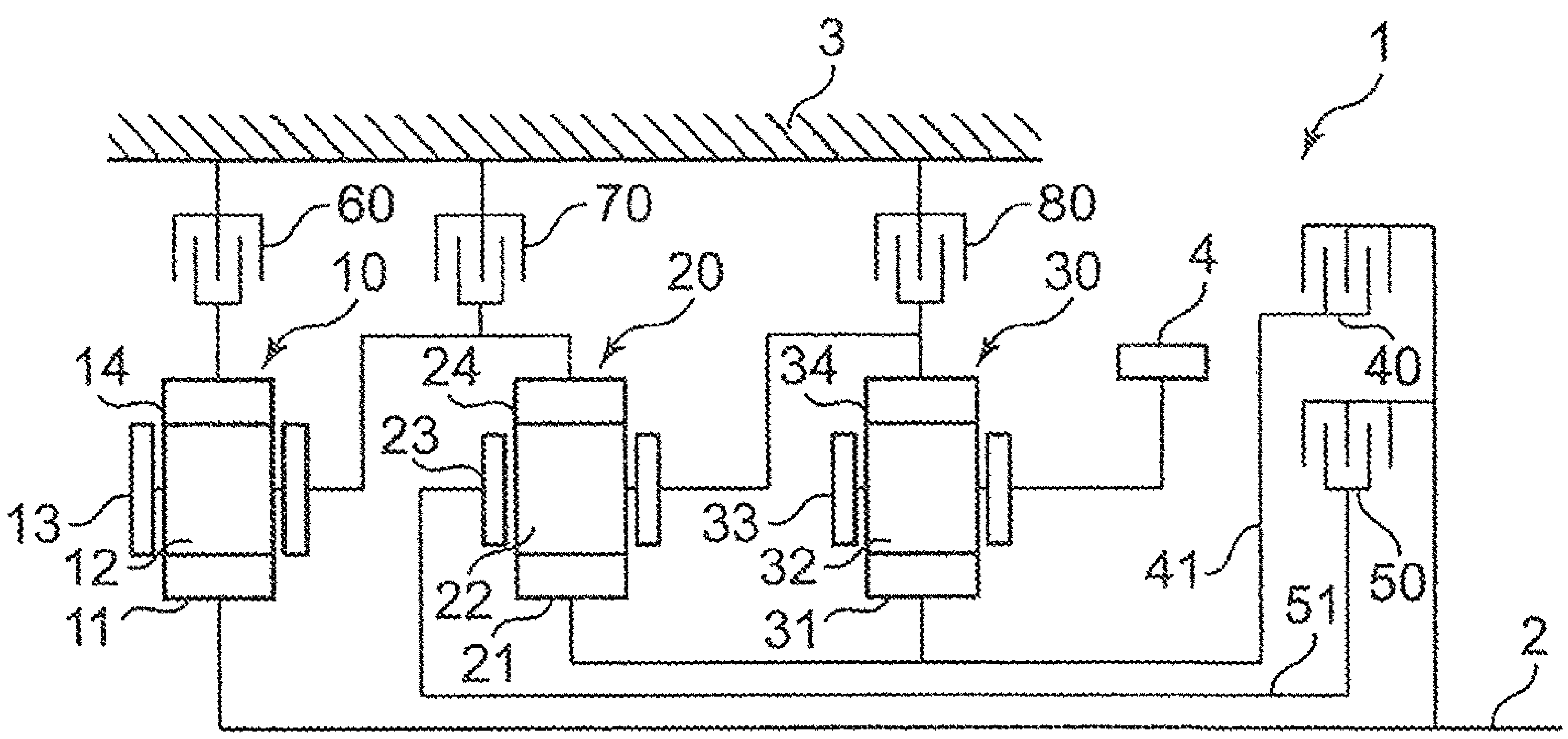


FIG. 2

	LOW CLUTCH (40)	HIGH CLUTCH (50)	R35 BRAKE (60)	26 BRAKE (70)	LR BRAKE (80)
FIRST GEAR POSITION	○				○
SECOND GEAR POSITION	○			○	
THIRD GEAR POSITION	○		○		
FOURTH GEAR POSITION	○	○			
FIFTH GEAR POSITION		○	○		
SIXTH GEAR POSITION		○		○	
REVERSE GEAR POSITION			○		○

FIG. 3

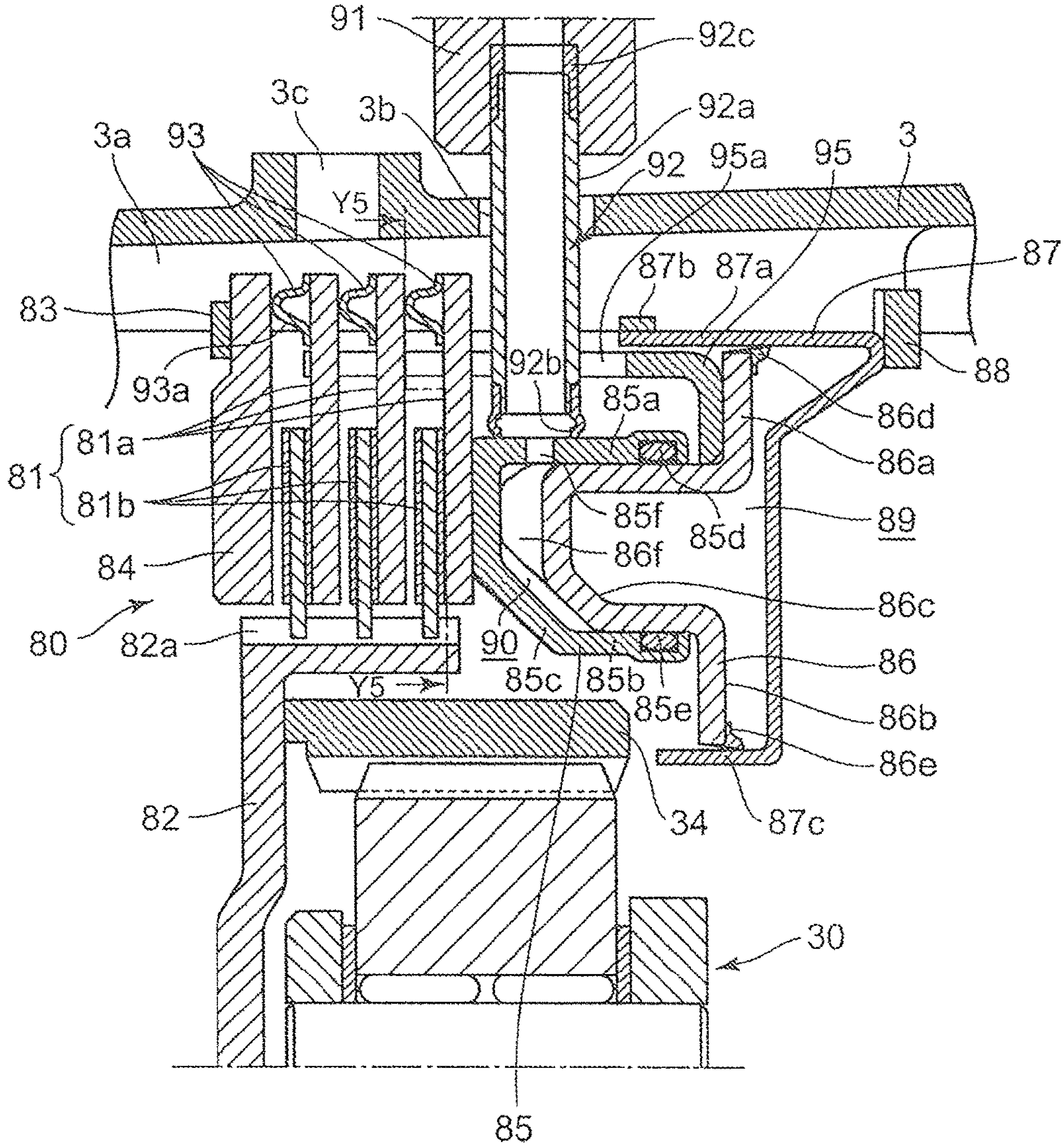

91
92c
3c
3b
92a
3a
93
92
95a
95
3
Y5
87b
87a
87
83
88
93a
92b
85a
86d
81a
86a
81
81b
85f
85d
89
86f
84
86c
80
82a
90
85c
85b
86
Y5
85e
86b
86e
82
34
87c
30
85

FIG. 4

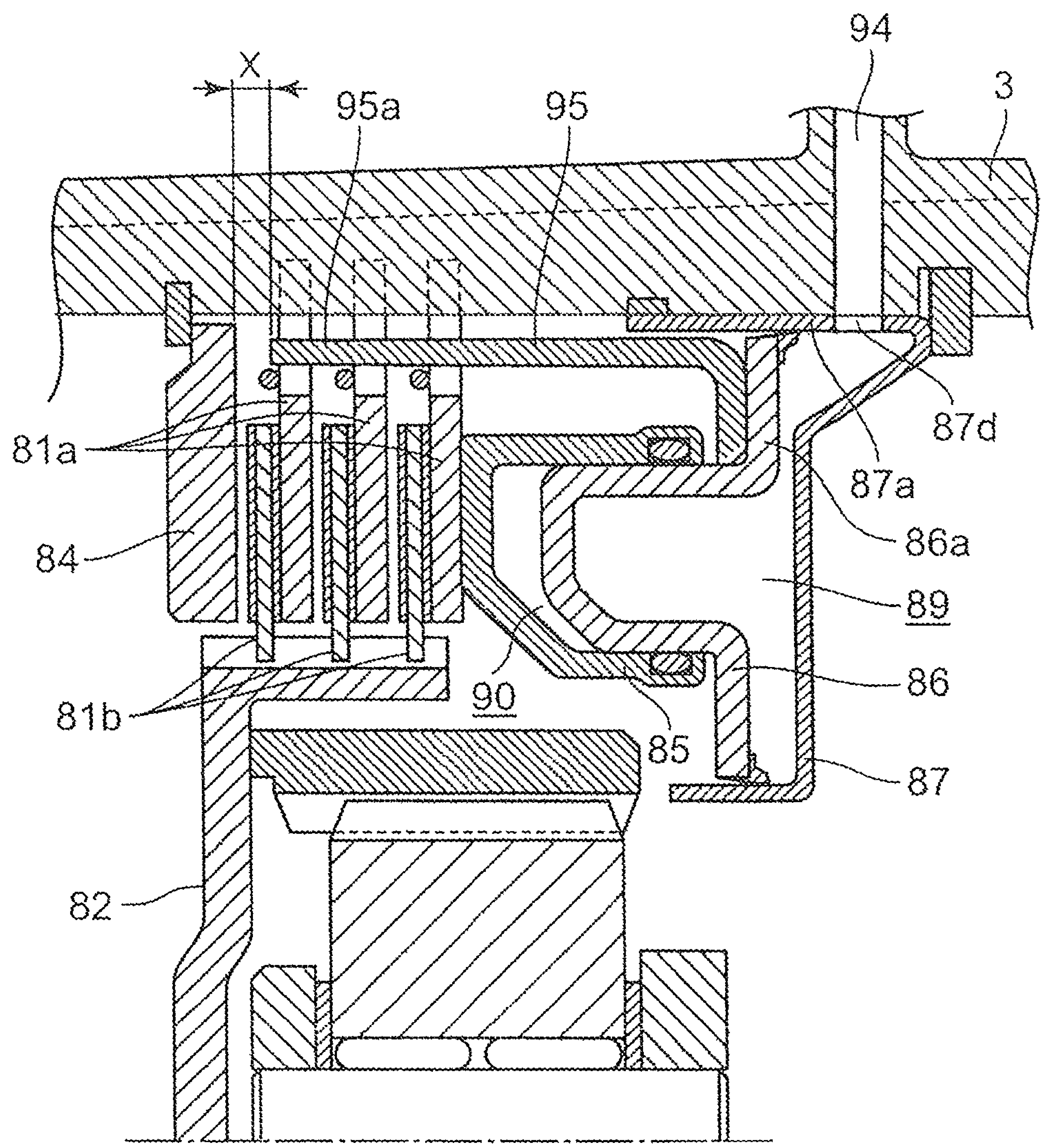


FIG. 5

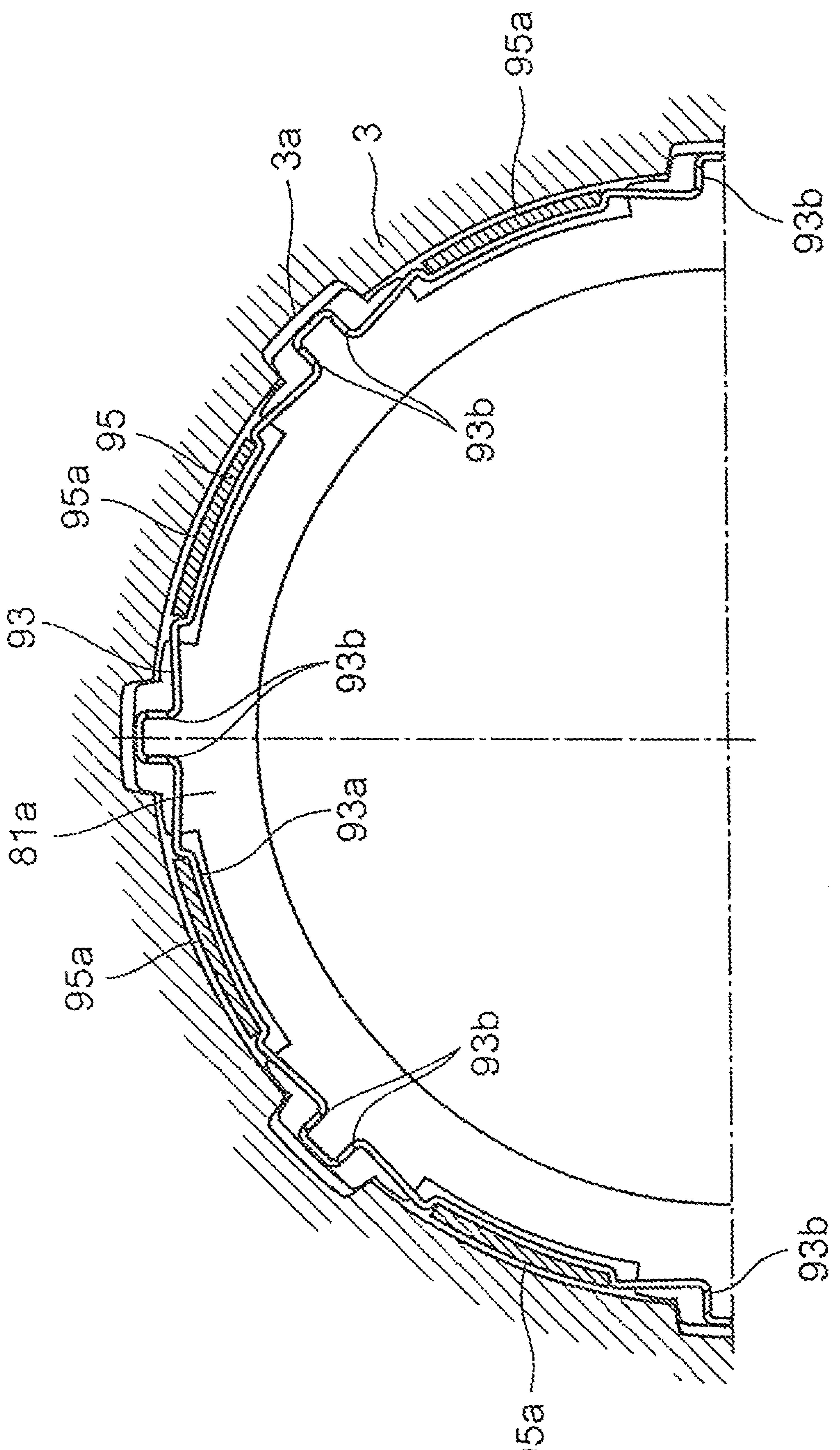


FIG. 6

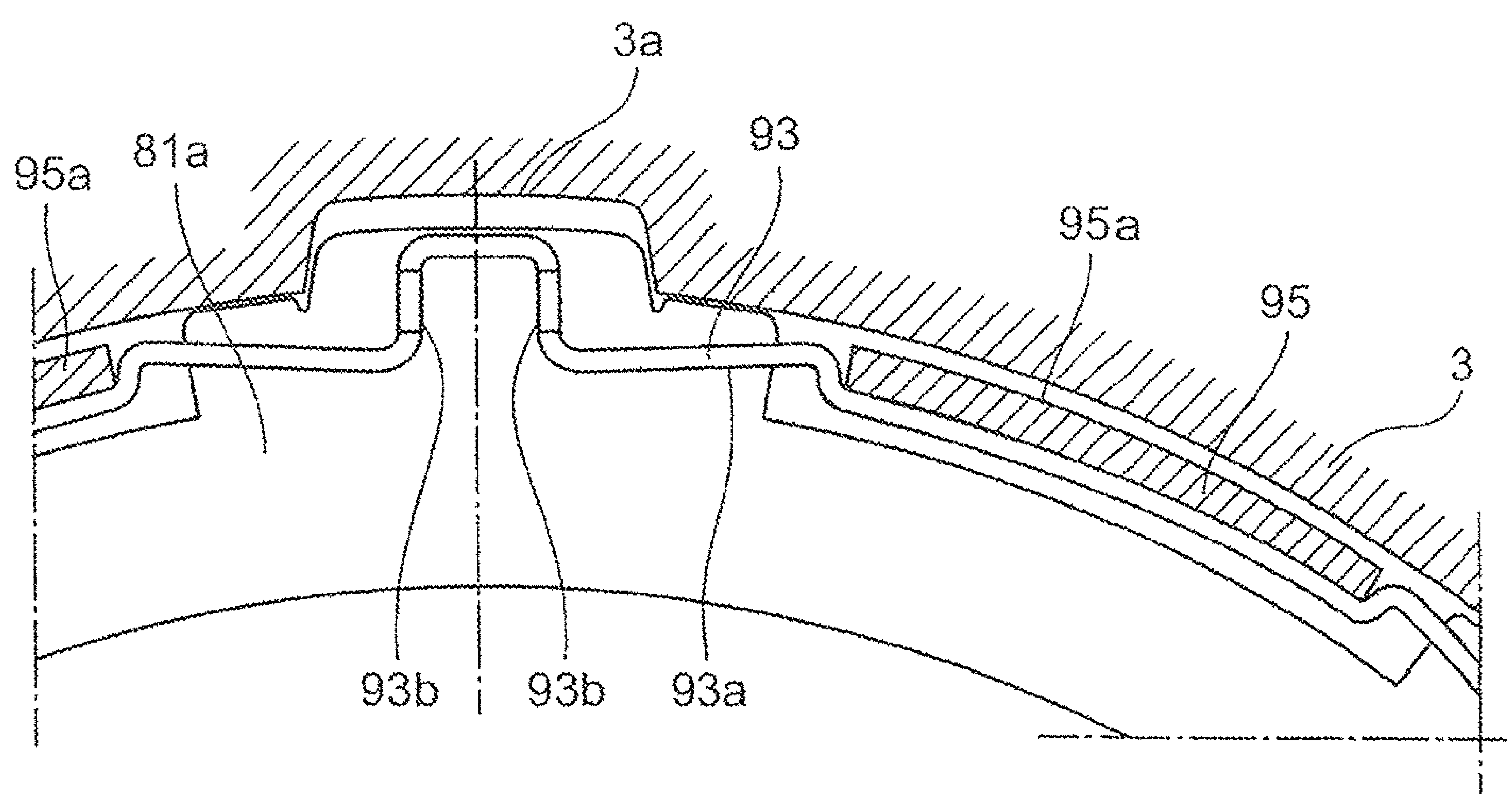


FIG. 7

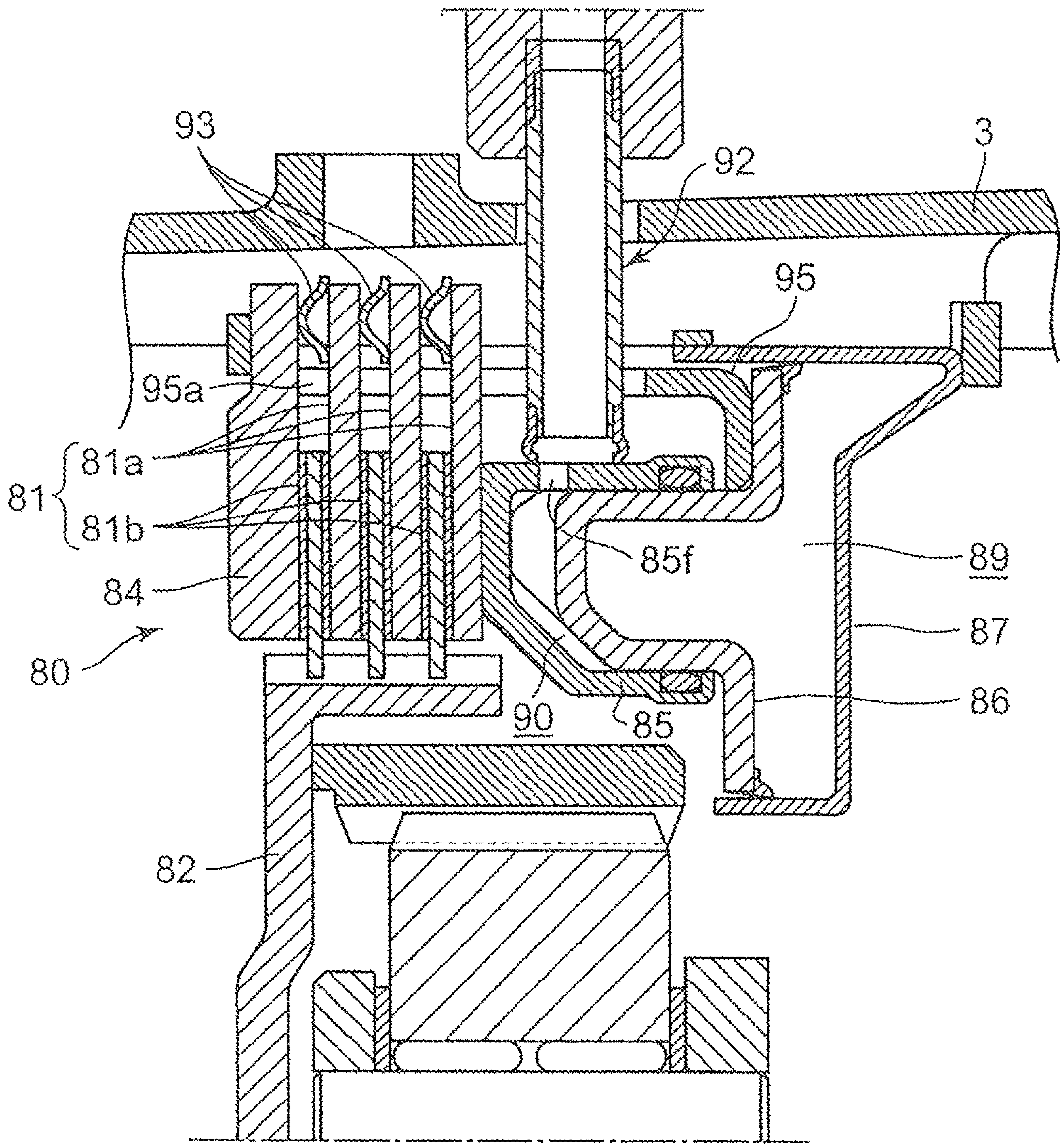


FIG. 8

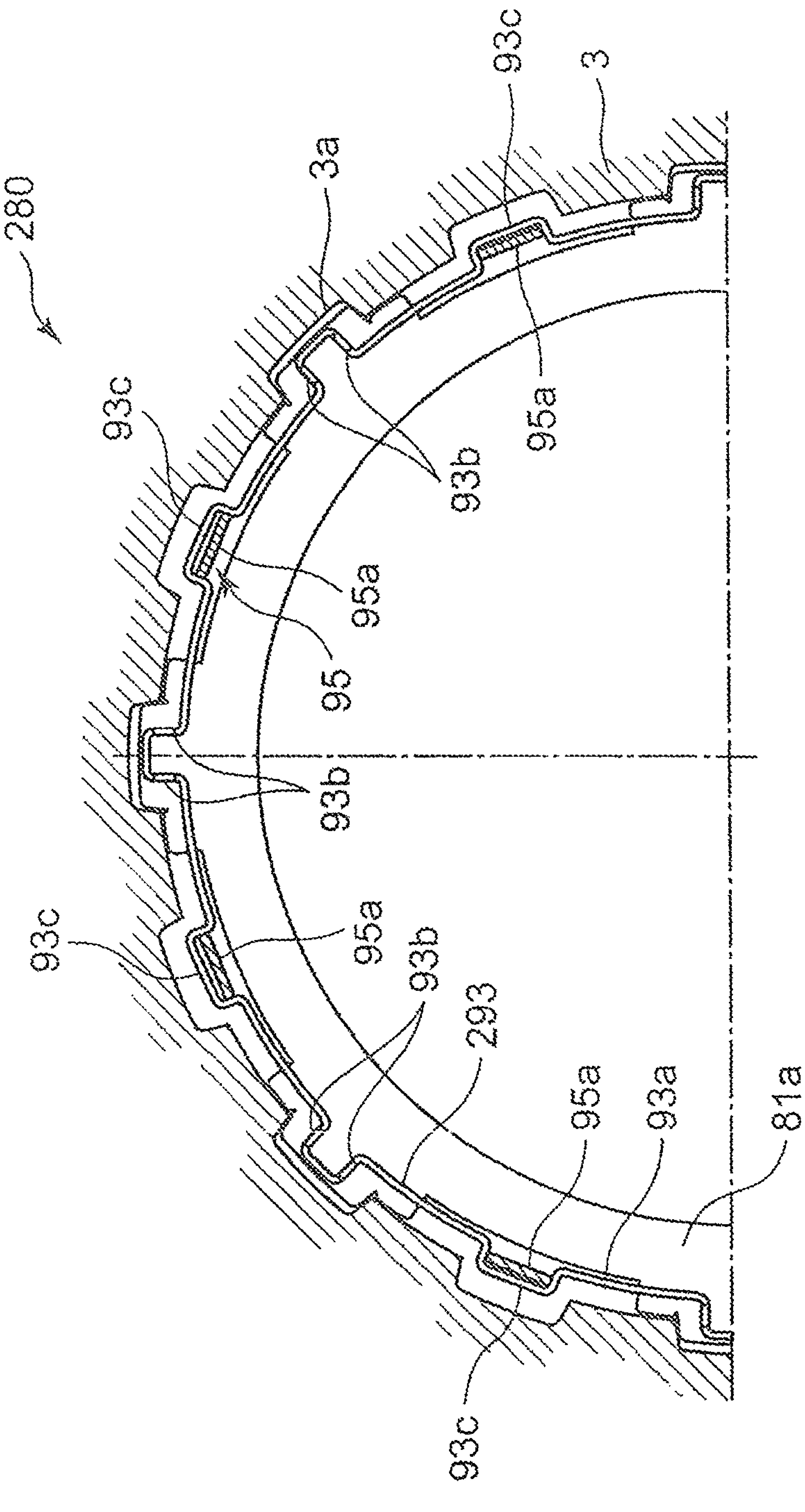


FIG. 9

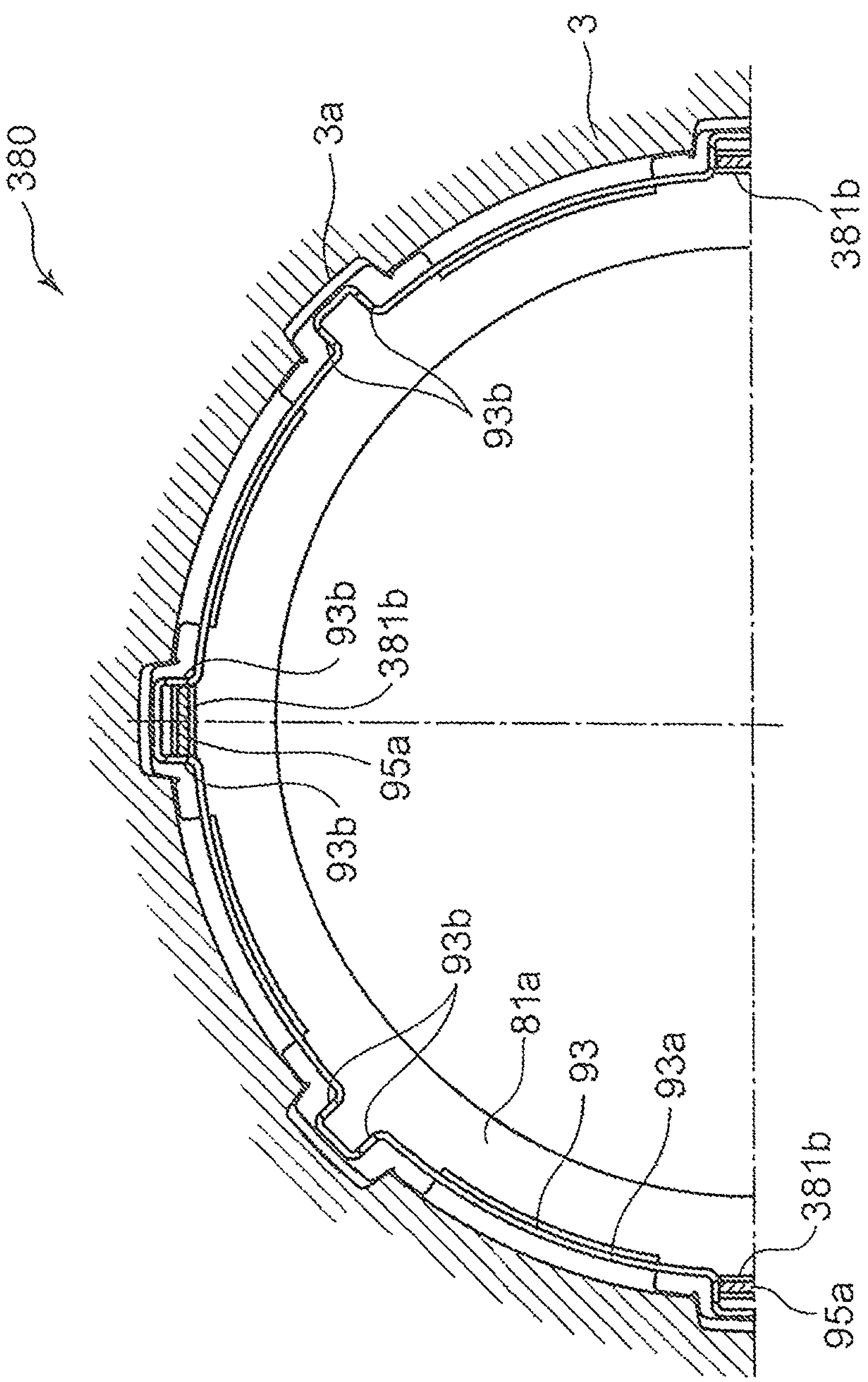


FIG. 10

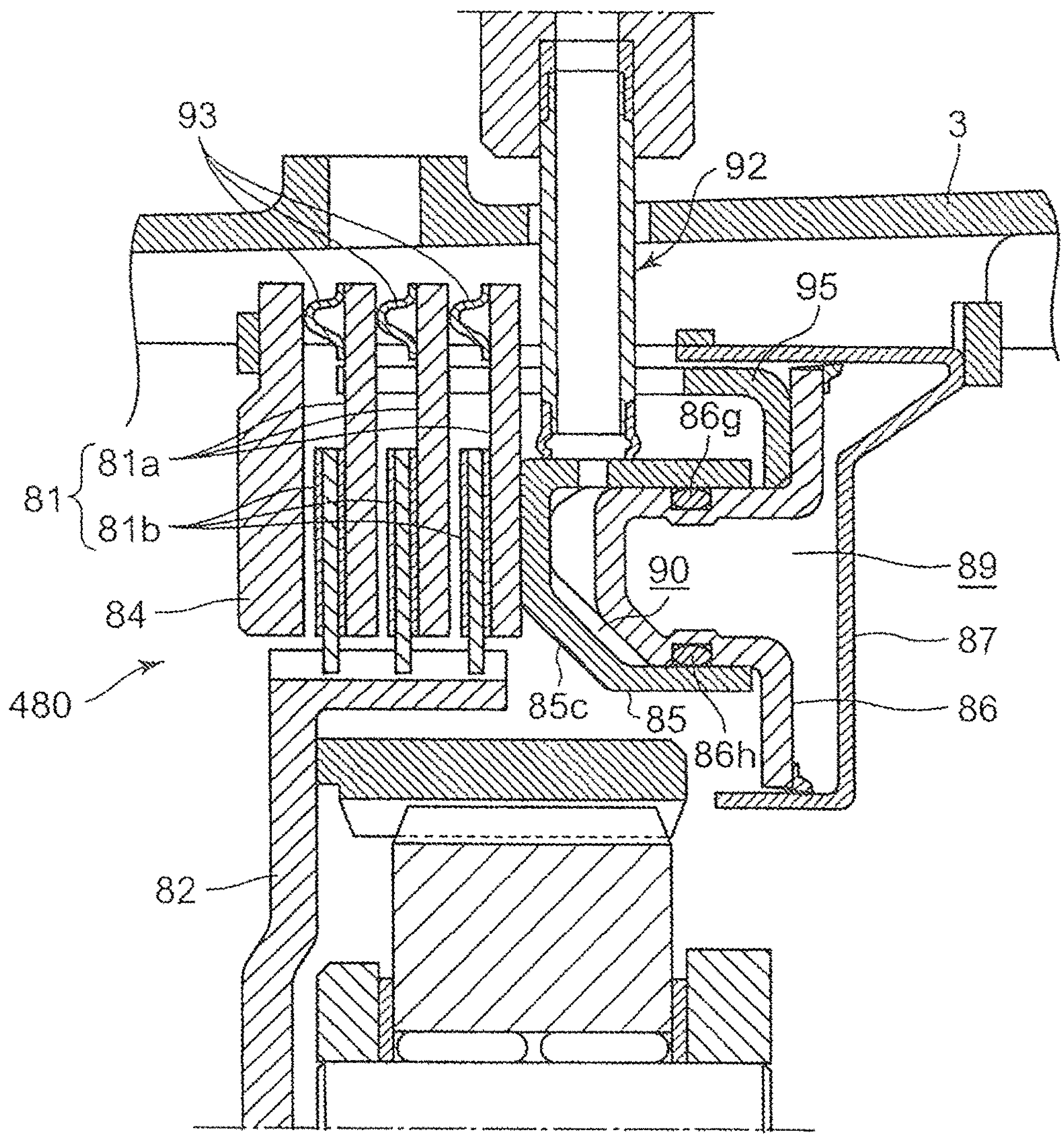


FIG. 11

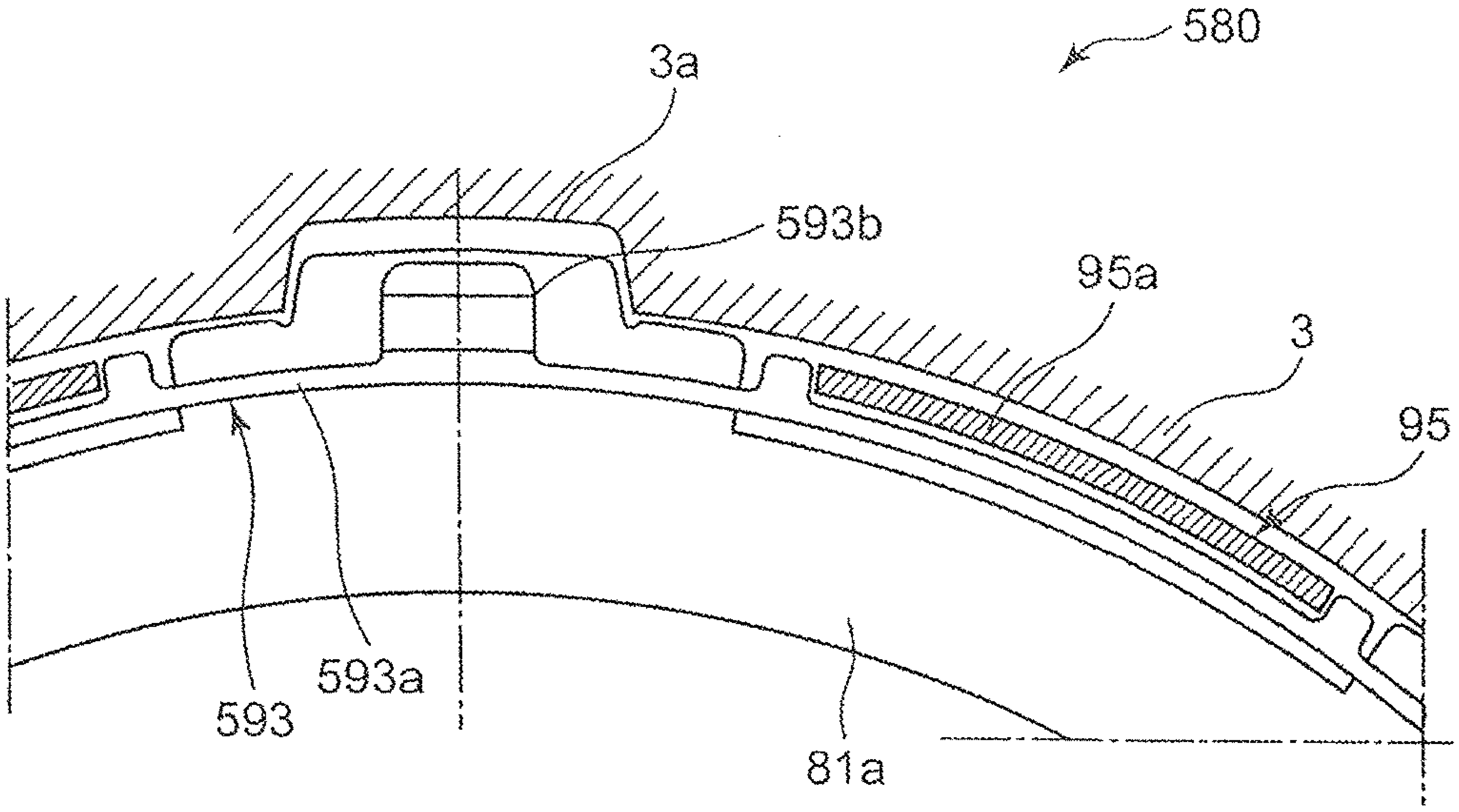


FIG. 12

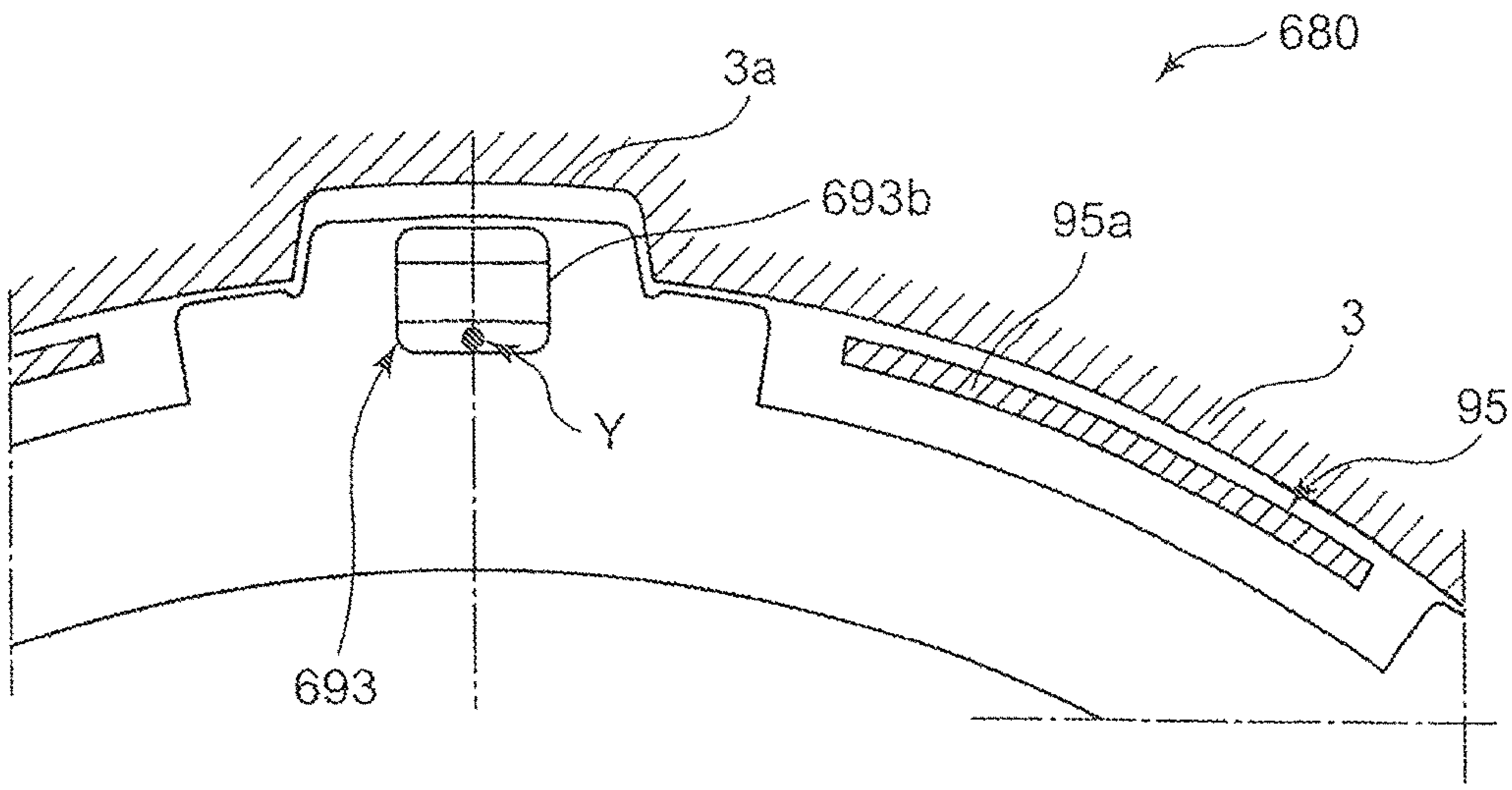


FIG. 13A

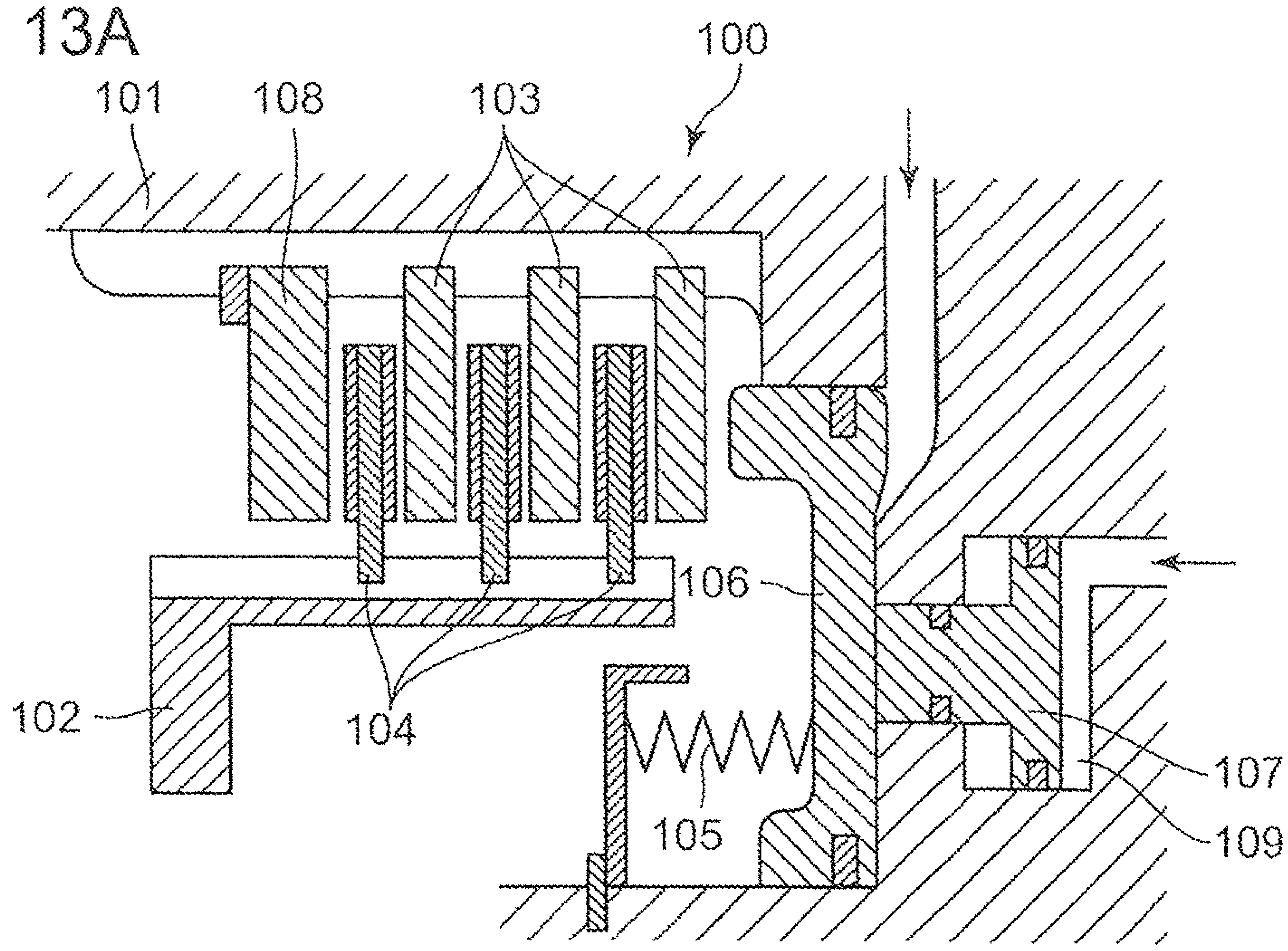
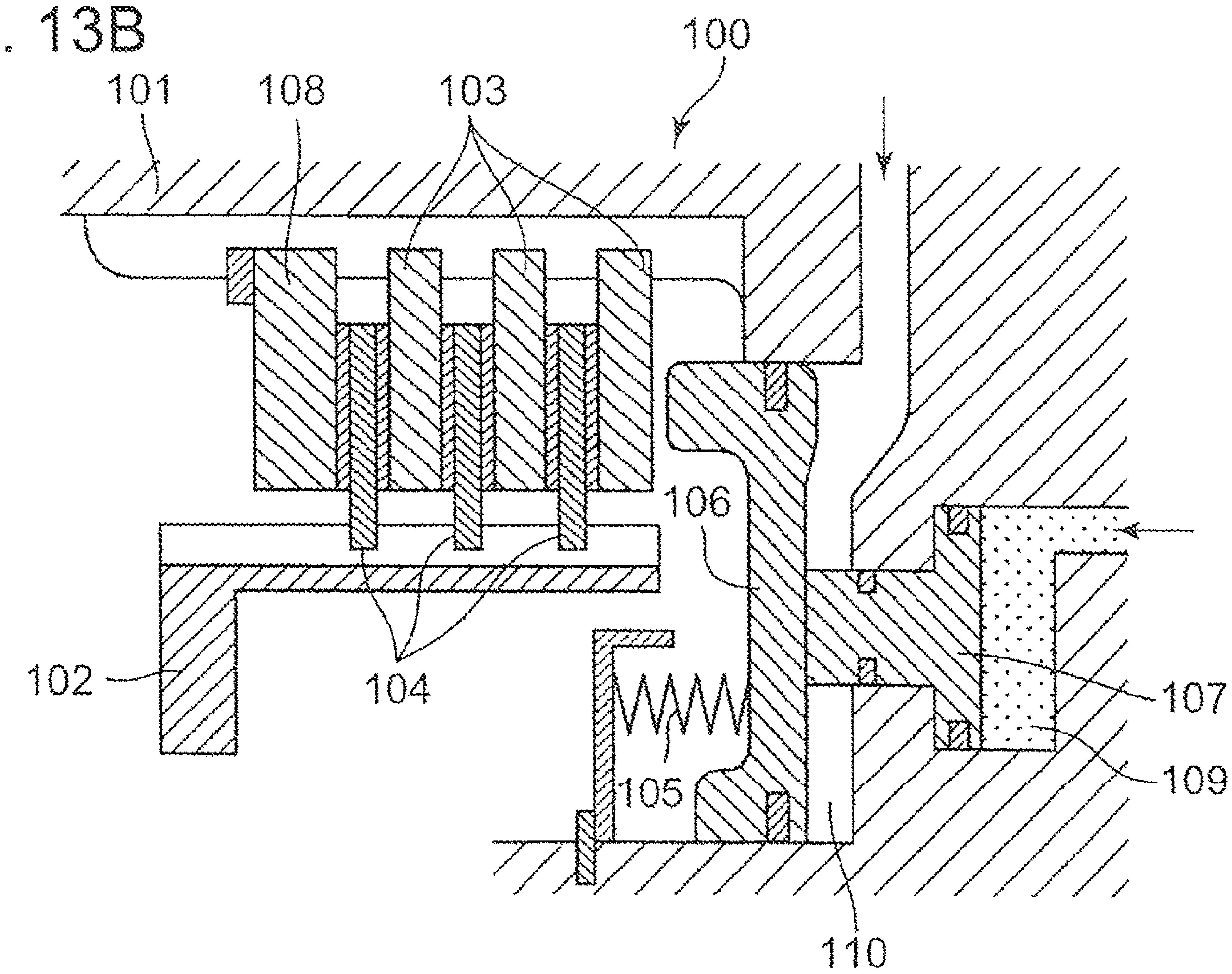


FIG. 13B



TRANSMISSION BRAKE DEVICE

TECHNICAL FIELD

The present invention relates to a transmission brake device to be mounted in a vehicle, and belongs to the technical field of a vehicular transmission.

BACKGROUND ART

A transmission to be mounted in a vehicle such as an automatic transmission is configured such that gearshift is automatically performed by selective engagement of a power transmission path constituted by a planetary gear mechanism and the like with a plurality of hydraulic friction engagement elements. Each gear position is basically formed by engagement of two friction engagement elements. Conventionally, regarding a first gear position in the D-range, it is a usual practice to form the gear position by one friction engagement element and an OWC (one-way clutch) for the purpose of a smooth gearshift operation and the like.

However, the OWC costs high. Further, a rotational resistance may be generated in a gear position other than the first gear position in the D-range. This may obstruct improvement of fuel economy of an engine. In view of the above, in recent years, abolishing use of the OWC is proposed or executed.

For instance, the first gear position is formed by engagement of a friction engagement element such as a low clutch, which is engaged with a predetermined low speed gear positions including the first gear position, and a friction engagement element such as a low reverse brake, which is engaged with the first gear position and a reverse gear position. Gearshift to the first gear position is performed by engagement of the latter friction engagement element in a state that the former friction engagement element is engaged. Therefore, in order to smoothly shift from another gear position to the first gear position, it is necessary to finely control the timing or the engaging force in engaging a friction engagement element such as the low reverse brake.

In order to cope with the aforementioned problem, Patent Literature 1 discloses a low reverse brake using a tandem hydraulic actuator including two pistons.

As illustrated in FIG. **13**A and FIG. **13**B, a brake device **100** is configured such that a plurality of fixed-side friction plates **103** that are spline-engaged with an inner surface of a transmission case, and a plurality of rotation-side friction plates **104** that are spline-engaged with an outer surface of a rotary member are alternately disposed between a transmission case **101**, and a rotary member **102** accommodated in the case **101**; and the brake device is provided with an engaging piston **106** for engaging the friction plates **103** and **104** against a biasing force of a return spring **105**, and a clearance adjustment piston **107** disposed behind the piston **106**.

In the brake device **100**, as illustrated in FIG. **13**A, at the time of non-engagement, the pistons **106** and **107** are held at a retracted position by a biasing force of the return spring **105**, and a relatively large clutch clearance (a value obtained by subtracting the sum of the thicknesses of all the friction plates from a distance between the engaging piston and a retaining plate) is formed.

When a hydraulic pressure is supplied to a hydraulic chamber **109** of the clearance adjustment piston **107** (hereinafter, referred to as a "clearance adjustment hydraulic chamber") from the aforementioned state, as illustrated in FIG. **13**B, the pistons **106** and **107** are advanced to a stroke end of the clearance adjustment piston **107** against a biasing force of the return spring **105**. Thereby, the clutch clearance is reduced by a distance by which the pistons **106** and **107** are advanced.

Therefore, by supplying a hydraulic pressure to the clearance adjustment hydraulic chamber **109**, it is possible to engage the friction plates **103** and **104** with enhanced responsiveness when a hydraulic pressure is supplied to a hydraulic chamber **110** of the engaging piston **106** (hereinafter, referred to as an "engagement hydraulic chamber"). Thus, it is possible to finely control the timing or the engaging force of an engaging operation. On the other hand, at the time of release, namely, when a hydraulic pressure is not supplied to the hydraulic chambers **109** and **110**, and the pistons **106** and **107** are held at a retracted position by a biasing force of the return spring **105**, a relatively large clutch clearance is formed. Therefore, a sliding resistance between the fixed-side friction plates **103** and the rotation-side friction plates **104**, namely, a resistance of a rotary member is small. This makes it possible to improve the fuel economy of an engine, and to suppress an increase in electric power consumption of a motor.

However, in the brake device described in Patent Literature 1, at the time of non-engagement, a gap between each adjacent pair of the friction plates may vary, and a sliding resistance between the friction plates may increase at a portion where the gap is small. An increase in the sliding resistance between the friction plates may lead to drive loss increase in a transmission as a whole, and may deteriorate the fuel economy.

CITATION LIST

Patent Literature

Patent Literature 1: Japanese Unexamined Patent Publication No. 2005-265063

SUMMARY OF INVENTION

An object of the present invention is to provide a transmission brake device including an engaging piston and a clearance adjustment piston, which enables to securely reduce a sliding resistance between friction plates at the time of non-engagement.

An aspect of the invention is directed to a transmission brake device including a friction plate set configured such that a plurality of rotation-side friction plates that are axially movably engaged with a predetermined rotary member, and a plurality of fixed-side friction plates that are axially movably engaged with a transmission case are alternately disposed; an engaging piston disposed on an axial side of the friction plate set; a clearance adjustment piston disposed on a side of the engaging piston opposite to the friction plate set, and configured to move the engaging piston toward the side of the friction plate set so as to adjust a clutch clearance; a clearance adjustment hydraulic chamber configured to move the clearance adjustment piston toward the side of the friction plate set when a hydraulic pressure is supplied to the clearance adjustment hydraulic chamber; and an engaging hydraulic chamber configured to move the engaging piston toward the side of the friction plate set when a hydraulic pressure is supplied to the engaging hydraulic chamber. The transmission brake device includes a biasing member disposed between each adjacent pair of the fixed-side friction plates, the biasing member being configured to bias each adjacent pair of the fixed-side friction plates in directions away from each other. The biasing member distributes the clutch clearance in a gap between each adjacent pair of the fixed-side friction plates when a hydraulic pressure is supplied only to the clearance adjustment hydraulic chamber out of the clearance adjustment hydraulic chamber and the engaging hydraulic chamber.

BRIEF DESCRIPTION OF DRAWINGS

FIG. **1** is a schematic diagram of an automatic transmission according to a first embodiment of the present invention;

FIG. **2** is a table illustrating a relationship between combinations of engagements of friction engagement elements, and gear positions;

FIG. **3** is a sectional view of a brake device according to the first embodiment;

FIG. **4** is a sectional view of the brake device according to the first embodiment taken along another section line;

FIG. **5** is a sectional view of the brake device taken along the line **Y5-Y5** in FIG. **3**;

FIG. **6** is an essential-part enlarged view enlargedly illustrating essential parts in FIG. **5**;

FIG. **7** is a sectional view illustrating a state when a hydraulic pressure is supplied to a clearance adjustment hydraulic chamber of the brake device according to the first embodiment;

FIG. **8** is an explanatory diagram (a diagram corresponding to FIG. **5**) of a brake device according to a second embodiment;

FIG. **9** is an explanatory diagram (a diagram corresponding to FIG. **5**) of a brake device according to a third embodiment;

FIG. **10** is a sectional view of a brake device according to a fourth embodiment;

FIG. **11** is an explanatory diagram (a diagram corresponding to FIG. **6**) of a brake device according to a fifth embodiment;

FIG. **12** is an explanatory diagram (a diagram corresponding to FIG. **6**) of a brake device according to a sixth embodiment; and

FIGS. **13**A and **13**B are sectional views illustrating a conventional brake device of an automatic transmission.

DESCRIPTION OF EMBODIMENTS

In the following, embodiments in which the present invention is applied to an automatic transmission are described.

FIG. **1** is a schematic diagram illustrating a configuration of an automatic transmission embodying the present invention. An automatic transmission **1** includes an input shaft **2** to which an engine output is input via a torque converter (not illustrated). A first planetary gear set **10**, a second planetary gear set **20**, and a third planetary gear set **30** (hereinafter, referred to as "first, second, and third gear sets") are disposed on the input shaft **2** in this order from the side opposite to the drive source side (from the left side in FIG. **1**). Further, the automatic transmission **1** is provided with, as hydraulic friction engagement elements for switching a power transmission path constituted by the gear sets **10**, **20**, and **30**, a low clutch **40** and a high clutch **50** for selectively transmitting power from the input shaft **2** to the gear sets **10**, **20**, and **30**; and a R35 brake **60**, a 26 brake **70**, and an LR brake **80** for fixing predetermined rotary elements of each of the gear sets **10**, **20**, and **30**.

The gear set **10** (**20**, **30**) is constituted by a sun gear **11** (**21**, **31**), a plurality of pinion gears **12** (**22**, **32**), each of which is engaged with the sun gear **11** (**21**, **31**), a carrier **13** (**23**, **33**) which supports the pinion gears **12**, (**22**, **32**), and a ring gear **14** (**24**, **34**) which is engaged with the pinion gears **12** (**22**, **32**).

The input shaft **2** is directly connected to the sun gear **11** of the first gear set **10**. The sun gear **21** of the second gear set **20**, and the sun gear **31** of the third gear set **30** are connected to each other, and are connected to an output member **41** of the low clutch **40**. Further, the carrier **23** of the second gear set **20** is connected to an output member **51** of the high clutch **50**.

Further, the R35 brake **60** is disposed between the ring gear **14** of the first gear set **10** and a transmission case **3**. The ring gear **24** of the second gear set **20** and the carrier **13** of the first gear set **10** are connected to each other. The 26 brake **70** is disposed between the ring gear **24** and the carrier **13**, and the transmission case **3**. Further, the ring gear **34** of the third gear set **30** and the carrier **23** of the second gear set **20** are connected to each other. The LR brake **80** is disposed between the ring gear **34** and the carrier **23**, and the transmission case **3**. Further, an output gear **4** for outputting an output of the automatic transmission **1** to drive wheels (not illustrated) is connected to the carrier **33** of the third gear set **30**.

As illustrated in FIG. **2**, the automatic transmission **1** having the aforementioned configuration provides first to sixth gear positions in the D-range, and a reverse gear position in the R-range by combining engagement states of the low clutch **40**, the high clutch **50**, the R35 brake **60**, the 26 brake **70**, and the LR brake **80**.

In this example, the LR brake **80** disposed on the outer peripheral side of the third gear set **30** in this embodiment corresponds to a brake device to which the present invention is applied. In the following, description is made based on the premise that the LR brake **80** is a brake device according to the present invention.

As illustrated in FIG. **3**, the brake device **80** according to the first embodiment includes a friction plate set **81** configured such that a plurality of fixed-sided friction plates **81***a* whose outer peripheral portion is engaged with a spline **3***a* formed on the inner surface of the transmission case **3**, and a plurality of rotation-side friction plates **81***b* whose inner peripheral portion is engaged with a spline **82***a* formed on the outer surface of a hub member **82** as a rotary member are alternately disposed. The hub member **82** is connected to the ring gear **34** of the third gear set **30**, and to the carrier **23** of the second gear set **20** illustrated in FIG. **1**.

A retaining plate **84** is disposed on the side opposite to the drive source side of the friction plate set **81** (hereinafter, the side opposite to the drive source side is referred to as a "rear side", and the drive source side is referred to as a "front side") in a state that the retaining plate **84** is engaged with the spline **3***a* of the transmission case **3** in the same manner as the fixed-side friction plates **81***a*, and slipping off thereof toward the rear side is prevented by a snap ring **83**.

On the front side of the friction plate set **81**, an engaging piston **85** for engaging the fixed-side friction plates **81***a* and the rotation-side friction plates **81***b*, a clearance adjustment piston **86** for moving the engaging piston **85** toward the side of the friction plate set so as to adjust a clutch clearance, and a cylinder **87** in which the pistons **85** and **86** are accommodated are disposed in this order. The clearance adjustment piston **86** is a piston for use in setting a clutch clearance small in advance at the time of engagement of the brake device **80**.

The cylinder **87** is a ring-shaped member made of a thin metal plate and having a generally U-shape in section. A projection **87***b* formed on an outer surface portion **87***a* of the cylinder **87** is engaged with the transmission case **3** in a state that the outer surface portion **87***a* is engaged in the inner surface of the transmission case **3** to prevent rotation of the cylinder **87**. Further, slipping off of the cylinder **87** toward the front side is prevented by a snap ring **88**.

The clearance adjustment piston **86** includes a flange portion **86***a* on the outer peripheral side and a flange portion **86***b* on the inner peripheral side, and a bulging portion **86***c* of a generally U-shape in section formed at a middle position radially of the flange portions **86***a* and **86***b* and bulging toward the friction plate set **81** on the rear side. The clearance adjustment piston **86** is placed into the cylinder **87** from the rear side. Seal members **86***d* and **86***e* mounted on the peripheral edges of the flange portions **86***a* and **86***b* respectively slidably and oil-tightly come into pressing contact with the inner surface of the outer surface portion **87***a* of the cylinder **87** and with the outer surface of an inner surface portion **87***c* of the cylinder **87**. Thus, a clearance adjustment hydraulic chamber **89** is oil-tightly formed by the cylinder **87** and the clearance adjustment piston **86**.

As illustrated in FIG. **4**, an adjustment hydraulic oil supply passage **94** is formed with respect to the clearance adjustment hydraulic chamber **89** in such a manner that the adjustment hydraulic oil supply passage **94** passes through the transmission case **3**, and is connected to an opening portion **87***d* formed in the outer surface portion **87***a* of the cylinder **87**.

When a hydraulic pressure for clearance adjustment is supplied to the clearance adjustment hydraulic chamber **89**, the clearance adjustment piston **86** is moved toward the side of the friction plate set **81**, thereby causing the engaging piston **85** to move toward the side of the friction plate set **81** via the clearance adjustment piston **86**. According to this configuration, in engagement of the friction plates **81***a* and **81***b*, the position of the engaging piston **85** is adjusted in advance to a position where a predetermined clutch clearance is formed.

A stopper member **95** is provided in the clearance adjustment piston **86** so that a stroke of the piston toward the side of the friction plate set **81** when a hydraulic pressure for clearance adjustment is supplied to the clearance adjustment hydraulic chamber **89** is set at a position where a predetermined clutch clearance is formed so as to minimize the clutch clearance.

The comb-shaped stopper member **95** extending toward the side of the friction plate set **81** while passing along the outer peripheral side of the engaging piston **85** is fixedly mounted to a surface of the flange portion **86***a* on the outer peripheral side of the clearance adjustment piston **86**, on the side of the friction plate set **81**. The stopper member **95** extends on the inner peripheral side of the inner surface of the transmission case **3**, and on the outer peripheral side of the rotation-side friction plates **81***b*.

A plurality of teeth **95***a* formed circumferentially of the stopper member **95** are configured such that as illustrated in FIG. **5** and FIG. **6**, the teeth **95***a* pass through a valley of a spline on the outer periphery of the fixed-side friction plates **81***a*, tip ends of the teeth **95***a* face the front surface of the retaining plate **84**, and as illustrated in FIG. **4**, a gap corresponding to a predetermined distance x is formed between a tip end surface of each of the teeth **95***a* and the front surface of the retaining plate **84** in a release state of the brake device **80**, namely, at a retracted position of the pistons **85** and **86**.

On the other hand, the engaging piston **85** includes a bulging portion **85***c* of a generally U-shape in section and bulging toward the friction plate set **81** on the rear side. The bulging portion **86***c* of the clearance adjustment piston **86** is received in the bulging portion **85***c* of the engaging piston **85**. An outer periphery and an inner periphery of the bulging portion **86***c* received in the bulging portion **85***c* are respectively slidably and oil-tightly sealed by seal members **85***d* and **85***e*.

The seal members **85***d* and **85***e* are mounted on groove portions for seal members, which are respectively formed in an outer circumferential wall **85***a* and in an inner circumferential wall **85***b* of the bulging portion **85***c* of the engaging piston **85**. An engaging hydraulic chamber **90** is oil-tightly formed by the engaging piston **85** and the clearance adjustment piston **86**.

In this example, a projecting portion **86***f* facing the inner surface of the engaging piston **85** is formed on the bulging portion **86***c* of the clearance adjustment piston **86** to restrict relative movement of the clearance adjustment piston **86** with respect to the engaging piston **85** toward the side of the friction plate set **81** at a predetermined position, and to secure a space of a predetermined volume, which serves as the engaging hydraulic chamber **90**.

Further, an oil supply port **85***f* is formed in the outer circumferential wall **85***a* of the bulging portion **85***c* of the engaging piston **85**. An oil supply pipe **92** extending from a hydraulic oil supply device **91** on the outside of the transmission case **3** passes through an opening portion **3***b* formed in the transmission case **3**, and extends radially inwardly toward the oil supply port **85***f*.

The oil supply pipe **92** includes a pipe body **92***a*, and a seal member **92***b* which is mounted to a tip end of the pipe body **92***a*, and is made of rubber, soft resin, or the like with a certain elasticity. By pressingly mounting the oil supply pipe **92** on the outer surface of the outer circumferential wall **85***a* of the bulging portion of the engaging piston **85** in a state that the tip end of the seal member **92***b* surrounds the oil supply port **85***f*, the oil supply pipe **92**, and the oil supply port **85***f* to the engaging hydraulic chamber **90** are oil-tightly communicated to each other within the stroke range of the engaging piston **85**.

Note that the oil supply pipe **92** extends radially from the outside toward the engaging piston **85** through a gap between the adjacent teeth of the stopper member **95** in order to avoid interference with the stopper member **95**.

Further, a seal member **92***c* is provided on an upper end of the pipe body **92***a* placed in the hydraulic oil supply device **91**. Further, although not illustrated, the opening portion **3***b* of the transmission case **3** is sealed in a state that the oil supply pipe **92** passes through the opening portion **3***b*. Further, the transmission case **3** is formed with an oil supply port **3***c* for supplying lubrication oil from the outside to the friction plate set **81** in the brake device **80**.

When a hydraulic pressure for engagement is supplied to the engaging hydraulic chamber **90** in a state that a hydraulic pressure for clearance adjustment is supplied to the clearance adjustment hydraulic chamber **89**, the engaging piston **85** is moved toward the side of the friction plate set **81**. Then, the fixed-side friction plates **81***a* and the rotation-side friction plates **81***b* constituting the friction plate set **81** are pressingly held between the engaging piston **85** and the retaining plate **84**. Thereby, the brake device **80** is engaged, and the hub member **82** to the carrier **23** of the second gear set **20**, and the ring gear **34** of the third gear set **30** are fixed.

Further, in the brake device **80**, a biasing member **93** is disposed between each adjacent pair of the fixed-side friction plates **81**a. The biasing member **93** is provided to resiliently bias each adjacent pair of the fixed-side friction plates **81**a in directions away from each other. A biasing member **93** configured in the same manner as described above is also disposed between the retaining plate **84**, and the fixed-side friction plate **81**a adjacent to the retaining plate **84**. These biasing members **93** are disposed on the outer peripheral side of the rotation-side friction plates **81**b.

In this example, as illustrated in FIG. **3** to FIG. **5**, for instance, the biasing member **93** is formed by bending a wire member. The biasing member **93** is provided with an annular body portion **93**a formed into an annular shape. A biasing portion **93**b for biasing each adjacent pair of the fixed-side friction plates **81**a, or the fixed-side friction plate **81**a and the retaining plate **84** adjacent to the fixed-side friction plate **81**a in directions away from each other is formed at plural positions circumferentially of the annular body portion **93**a.

Each of the biasing portions **93**b is formed to project toward the rear side by bending a wire member into a generally V-shape in section. The biasing portion **93**b is disposed such that the open angle between a pair of slope portions of a generally V-shape is resiliently changeable, and a biasing force can be axially imparted in a state that the biasing portion **93**b is axially compressed, in other words, in a state that the open angle is set large.

The biasing members **93** having the same configuration as each other are disposed between each adjacent pair of the fixed-side friction plates **81**a, and between the retaining plate **84** and the fixed-side friction plate **81**a adjacent to the retaining plate **84**. The biasing members **93** are provided to distribute a clutch clearance in a gap between each adjacent pair of the fixed-side friction plates. Further, these biasing members **93** also function as a return spring for moving the engaging piston **85** toward the side opposite to the side of the friction plate set.

Next, an operation of the first embodiment is described. At the time of engagement, a hydraulic pressure is supplied from the state illustrated in FIG. **3** and FIG. **4** to the clearance adjustment hydraulic chamber **89** through the adjustment hydraulic oil supply passage **94**. By supply of the hydraulic pressure, the clearance adjustment piston **86** is stroked toward the side of the friction plate set **81**, and the projecting portion **86**f formed at a tip end of the bulging portion **86**c of the clearance adjustment piston **86** is abutted against the inner surface of the engaging piston **85**. Thereby, the engaging piston **85** is also stroked toward the side of the friction plate set **81**.

Then, at a point of time when the clearance adjustment piston **86** is stroked or moved by the distance x, the tip ends of the teeth **95**a of the comb-shaped stopper member **95** formed on the clearance adjustment piston **86** are abutted against the front surface of the retaining plate **84**, and strokes of the pistons **85** and **86** are restricted in this state.

In this state, as illustrated in FIG. **7**, the gap between each adjacent pair of the fixed-side friction plates **81**a and **81**a, and the gap between the rearmost fixed-side friction plate **81**a and the retaining plate **84** are narrowed against biasing forces of the biasing members **93**, and the clutch clearance is set to a very small value close to 0 e.g. 1 mm. The clutch clearance is distributed in a gap between each adjacent pair of the fixed-side friction plates.

Next, a hydraulic pressure is supplied to the engaging hydraulic chamber **90** by the oil supply pipe **92**. When the engaging piston **85** presses the friction plate set **81**, and the friction plate set **81** is pressed against the retaining plate **84**, the rotation-side friction plates **81**b are pressingly held between the fixed-side friction plates **81**a and the retaining plate **84**. Thus, the brake device **80** is engaged.

The clutch clearance is set to a very small value close to 0 in advance. Therefore, the brake device **80** is engaged speedily by supply of a hydraulic pressure for engagement, and an engaging operation with high responsiveness is obtained. On the other hand, when the brake device **80** is in a release state, namely, when the pistons **85** and **86** are located at a retracted position, a large clutch clearance is secured. Therefore, an increase in rotational resistance by slide contact of the fixed-sided friction plates **81**a and the retaining plate **84** with the rotation-side friction plates **81**b is suppressed. This makes it possible to improve the fuel economy of an engine in a release state, and to obtain enhanced responsiveness at the time of engagement of the brake device **80**.

As described above, in the brake device **80** according to the first embodiment, the engaging piston **85** and the clearance adjustment piston **86** are disposed on an axial side of the friction plate set **81** constituted by the fixed-side friction plates **81**a and the rotation-side friction plates **81**b; the biasing member **93** for biasing each adjacent pair of the fixed-side friction plates **81**a in directions away from each other is disposed between each adjacent pair of the fixed-side friction plates **81**a; and the biasing member **93** is provided in such a manner that a clutch clearance is distributed in a gap between each adjacent pair of the fixed-side friction plates when a hydraulic pressure is supplied only to the clearance adjustment hydraulic chamber **89**.

According to the aforementioned configuration, it is possible to suppress a variation in the gap between each adjacent pair of the fixed-side friction plates **81**a, and to make the gaps substantially uniform when a clutch clearance is reduced. This makes it possible to reduce a sliding resistance between friction plates, as compared with a configuration, in which the gaps are non-uniform. This is advantageous in improving the fuel economy.

Further, the biasing member **93** disposed between each adjacent pair of the fixed-side friction plates **81**a can be used as a return spring for moving the engaging piston **85** toward the side opposite to the side of the friction plate set. This is advantageous in obtaining the aforementioned effects without the need of additionally providing a return spring.

Further, the biasing member **93** is circumferentially provided with a plurality of the biasing portions **93**b for biasing each adjacent pair of the fixed-side friction plates **81**a in directions away from each other. This makes it possible to reduce the number of steps of assembling a biasing member, as compared with a configuration, in which a plurality of biasing members are provided circumferentially in a gap between each adjacent pair of the fixed-side friction plates **81**a. This is advantageous in improving productivity.

Further, the engaging hydraulic chamber **90** is formed by the bulging portion **85**c of the engaging piston **85** bulging toward the side of the friction plate set **81**, and the bulging portion **86**c of the clearance adjustment piston **86** bulging toward the side of the friction plate set **81** and received in the bulging portion **85**c. This makes it possible to keep the volume of the engaging hydraulic chamber **90** substantially unchanged when the clearance adjustment piston **86** is moved toward the side of the friction plate set **81**. According to this configuration, as compared with a configuration, in which the volume of an engaging hydraulic chamber is increased, as exemplified by the brake device **100** illustrated in FIG. **13**A and FIG. **13**B, it is possible to form the engaging hydraulic chamber **90** with a small size. Forming the engaging hydraulic chamber **90** with a small size is advantageous in engaging the friction plates with enhanced responsiveness, and in finely controlling the timing or the engaging force of an engaging operation.

Further, the stopper member **95** is fixed to the clearance adjustment piston **86**, and extends axially toward the other side with respect to the clearance adjustment piston **86**. The stopper member **95** is configured such that the axial other end of the clearance adjustment piston **86** is abutted against the retaining plate **84** when the clearance adjustment piston **86** is moved toward the side of the friction plate set **81** to restrict movement of the clearance adjustment piston **86** at a position where a predetermined clutch clearance is formed.

According to this configuration, for instance, it is possible to securely restrict movement of the clearance adjustment piston with a relatively simplified configuration, without forming a groove portion for a seal member to mount the seal member, as exemplified by the brake device **100** illustrated in FIG. **13**A and FIG. **13**B, or forming a groove portion for a snap ring to mount the snap ring. Further, the aforementioned configuration is advantageous in improving productivity, as compared with a configuration, in which a groove portion for a seal member is formed in a clearance adjustment piston to mount the seal member, or a groove portion for a snap ring is formed to mount the snap ring.

In the brake device **80** according to the first embodiment, as illustrated in FIG. **5** and FIG. **6**, the teeth **95***a* of the stopper member **95** extend along the outer peripheral side of the biasing members **93**. Alternatively, as exemplified by a brake device **280** according to a second embodiment illustrated in FIG. **8**, it is possible to extend the teeth of a stopper member along the inner peripheral side of biasing members.

In the brake device **280** according to the second embodiment, a biasing member **293** is formed with convex portions **93***c*, each of which projects into a rectangular shape on the outer peripheral side of an annular body portion **93***a* of the biasing member **293**. Teeth **95***a* of a stopper member **95** extend through a gap between a transmission case **3** and fixed-side friction plates **81***a*, and extend on the inner peripheral side of the convex portions **93***c* of the biasing member **293**.

Also, in this embodiment, the stopper member **95** is abutted against a retaining plate **84** when a clearance adjustment piston **86** is moved toward the side of a friction plate set **81** to restrict movement of the clearance adjustment piston **86** at a position where a predetermined clutch clearance is formed. This is advantageous in securely restricting movement of the clearance adjustment piston with a relatively simplified configuration.

Further, in the brake device **80** of the first embodiment, and in the brake device **280** of the second embodiment, the teeth **95***a* of the stopper member **95** extend through a gap between the transmission case **3** and the fixed-side friction plates **81***a*. Alternatively, as exemplified by a brake device **380** according to a third embodiment illustrated in FIG. **9**, it is possible to extend the teeth of a stopper member through fixed-side friction plates **81***a*.

In the brake device **380** according to the third embodiment, teeth **95***a* of a stopper member **95** extend through a substantially rectangular through-hole **381***b* formed on the outer peripheral side of the fixed-side friction plates **81***a*. Further, the teeth **95***a* of the stopper member **95** extend on the inner peripheral side of biasing members **93** in the same manner as in the brake device **280**.

Also, in this embodiment, the stopper member **95** is abutted against a retaining plate **84** when a clearance adjustment piston **86** is moved toward the side of a friction plate set **81** to restrict movement of the clearance adjustment piston **86** at a position where a predetermined clutch clearance is formed. According to this configuration, it is possible to securely restrict movement of the clearance adjustment piston with a relatively simplified configuration.

Further, in the brake device **80** according to the first embodiment, a portion of the bulging portion **85***c* of the engaging piston **85** in which the bulging portion **86***c* of the clearance adjustment piston **86** is received is sealed by the seal members **85***d* and **85***e* provided on the engaging piston **85**. Alternatively, as exemplified by a brake device **480** according to a fourth embodiment illustrated in FIG. **10**, a seal member may be provided on a clearance adjustment piston for sealing.

In the brake device **480** according to the fourth embodiment, seal members **86***g* and **86***h* are mounted on groove portions for seal members, which are respectively formed in the outer peripheral wall and in the inner peripheral wall of a bulging portion **86***c* of a clearance adjustment piston **86**, and an outer periphery and an inner periphery of a bulging portion **85***c* of an engaging piston **85** in which the bulging portion **86***c* of the clearance adjustment piston **86** is received are respectively sealed by the seal members **86***g* and **86***h*. Thus, an engaging hydraulic chamber **90** is oil-tightly formed by the engaging piston **85** and the clearance adjustment piston **86**.

Also, in this embodiment, the engaging hydraulic chamber **90** is formed by the bulging portion **85***c* of the engaging piston **85** bulging toward the side of a friction plate set **81**, and the bulging portion **86***c* of the clearance adjustment piston **86** bulging toward the side of the friction plate set **81** and received in the bulging portion **85***c*. According to this configuration, it is possible to keep the volume of an engaging hydraulic chamber **89** substantially unchanged when the clearance adjustment piston **86** is moved toward the side of the friction plate set **81**. This makes it possible to form the engaging hydraulic chamber **90** with a small size. Forming the engaging hydraulic chamber **90** with a small size is advantageous in engaging the friction plates with enhanced responsiveness, and in finely controlling the timing or the engaging force of an engaging operation.

Further, in the brake device **80** according to the first embodiment, the biasing member **93** is formed by bending a wire member. Alternatively, as exemplified by a brake device **580** according to a fifth embodiment illustrated in FIG. **11**, it is possible to form a biasing member by press-molding a plate-shaped member.

In the brake device **580** according to the fifth embodiment, a biasing member **593** is formed by press-molding a plate-shaped member. An annular body portion **593***a* is circumferentially formed with a biasing portion **593***b* at plural positions. Each of the biasing portions **593***b* is formed to project toward the rear side by bending the biasing portion **593***b* into a substantially V-shape in section in the same manner as the biasing portion **93***b* of the biasing member **93**. As illustrated in FIG. **11**, the biasing portion **593***b* is formed into a rectangular shape in plan view. Thus, the area of the biasing portion **593***b* in contact with a fixed-side friction plate **81***a* is made large, as compared with the biasing member **93**.

Also, in this embodiment, the biasing member **593** for resiliently biasing each adjacent pair of the fixed-side friction plates **81***a* in directions away from each other are disposed between each adjacent pair of the fixed-side friction plates **81***a*. The biasing member **593** is provided in such a manner that a clutch clearance is distributed in a gap between each adjacent pair of the fixed-side friction plates when a hydraulic pressure is supplied only to a clearance adjustment hydraulic chamber **89**.

According to the aforementioned configuration, it is possible to suppress a variation in the gap between each adjacent pair of the fixed-side friction plates **81***a*, and to make the gaps substantially uniform when a clutch clearance is reduced. This makes it possible to reduce a sliding resistance between friction plates, as compared with a configuration, in which the gaps are non-uniform. This is advantageous in improving the fuel economy.

Further, in the brake device **580** according to the fifth embodiment, the annular body **593***a* of the biasing member **593** is circumferentially formed with the biasing portion **593***b* at plural positions. Alternatively, as exemplified by a brake device **680** according to a sixth embodiment illustrated in FIG. **12**, it is possible to form a plurality of biasing members circumferentially at plural positions, respectively, without forming an annular body portion of a biasing member.

In the brake device **680** according to the sixth embodiment, a biasing member **693** is formed in the same manner as the biasing portion **593***b* of the biasing member **593** according to the fifth embodiment. The biasing member **693** is disposed circumferentially at plural positions. The biasing member **693** is formed to project toward the rear side by bending the biasing member **693** into a substantially V-shape in section in the same manner as the biasing portion **593***b* of the biasing member **593**. Then, only the inner peripheral portion of the biasing member **693** is connected to a fixed-sided friction plate **81***a* by rivet joint or the like at a position indicated by the symbol Y in FIG. **12**.

Also, in this embodiment, a biasing member **693***b* for biasing each adjacent pair of the fixed-side friction plates **81***a* in directions away from each other is disposed between each adjacent pair of the fixed-side friction plates **81***a*. The biasing member **693***b* is provided to distribute a clutch clearance in a gap between each adjacent pair of the fixed-side friction plates when a hydraulic pressure is supplied only to a clearance adjustment hydraulic chamber **89**.

According to this configuration, it is possible to suppress a variation in the gap between each adjacent pair of the fixed-side friction plates **81***a*, and to make the gaps substantially uniform when a clutch clearance is reduced. This makes it possible to reduce a sliding resistance between friction plates, as compared with a configuration, in which the gaps are non-uniform. This is advantageous in improving the fuel economy.

In the embodiments illustrated in FIG. **3** and FIG. **10**, the outer peripheral portion of each of the fixed-side friction plates **81***a* is engaged with the spline **3***a* formed on the inner surface of the transmission case **3**, and the inner peripheral portion of each of the rotation-side friction plates **81***b* is engaged with the spline **82***a* formed on the outer surface of the hub member **82**. The retaining plate **84** is fixed to the inner surface of the transmission case **3**. Alternatively, the relationship between the fixed-side friction plates **81***a* and the rotation-side friction plates **81***b* may be reversed. Specifically, a spline may be formed on the inner surface of the hub member **82**, and an outer peripheral portion of each of the rotation-side friction plates **81***b* may be engaged with the spline. Then, a sleeve member may be disposed inside the hub member **82**, and the sleeve member including an outer surface which faces the inner surface of the hub member **82** may be connected to the inner surface of the transmission case **3**. A spline may be formed on the outer surface of the sleeve member, and the inner peripheral portion of each of the fixed-side friction plates **81***a* may be engaged with the spline. In this case, a retaining plate is fixed to the sleeve member.

In the foregoing embodiments, the LR brake **80** is described as a brake device according to the present invention. The present invention is also applicable to a brake device such as the R35 brake **60** and the 26 brake **70**. Further, the present invention is also applicable to a friction engaging device such as a low clutch and a high clutch, wherein a clutch hub as an inner rotary member, and a clutch drum as an outer rotary member are axially disposed in an overlapping manner, in place of using a transmission case and a predetermined rotary member.

The present invention is not limited to the exemplified embodiments. Various improvements and design modifications are applicable as far as such improvements and design modifications do not depart from the gist of the present invention.

The following is a summary of the present invention.

Specifically, the present invention is directed to a transmission brake device including a friction plate set configured such that a plurality of rotation-side friction plates that are axially movably engaged with a predetermined rotary member, and a plurality of fixed-side friction plates that are axially movably engaged with a transmission case are alternately disposed; an engaging piston disposed on an axial side of the friction plate set; a clearance adjustment piston disposed on a side of the engaging piston opposite to the friction plate set, and configured to move the engaging piston toward the side of the friction plate set so as to adjust a clutch clearance; a clearance adjustment hydraulic chamber configured to move the clearance adjustment piston toward the side of the friction plate set when a hydraulic pressure is supplied to the clearance adjustment hydraulic chamber; and an engaging hydraulic chamber configured to move the engaging piston toward the side of the friction plate set when a hydraulic pressure is supplied to the engaging hydraulic chamber. The transmission brake device includes a biasing member disposed between each adjacent pair of the fixed-side friction plates, the biasing member being configured to bias each adjacent pair of the fixed-side friction plates in directions away from each other. The biasing member distributes the clutch clearance in a gap between each adjacent pair of the fixed-side friction plates when a hydraulic pressure is supplied only to the clearance adjustment hydraulic chamber out of the clearance adjustment hydraulic chamber and the engaging hydraulic chamber.

According to the aforementioned configuration, it is possible to suppress a variation in the gap between each adjacent pair of the fixed-side friction plates, and to make the gaps substantially uniform when a clutch clearance is reduced. This makes it possible to reduce a sliding resistance between friction plates, as compared with a configuration, in which the gaps are non-uniform. This is advantageous in improving the fuel economy.

Further, the biasing member which is disposed between each adjacent pair of the fixed-side friction plates can be used as a return spring for moving the engaging piston toward the side opposite to the side of the friction plate set. This is advantageous in obtaining the aforementioned effects without the need of additionally providing a return spring.

In the brake device, preferably, the biasing member may be circumferentially provided with a plurality of biasing portions for biasing each adjacent pair of the fixed-side friction plates in the directions away from each other.

According to the aforementioned configuration, it is possible to reduce the number of steps of assembling a biasing member, as compared with a configuration, in which a plurality of biasing members are provided circumferentially in a gap between each adjacent pair of the fixed-side friction plates. This is advantageous in improving productivity.

Further, in the brake device, preferably, the engaging piston may be provided with a bulging portion bulging toward the side of the friction plate set, the clearance adjustment piston may be provided with a bulging portion bulging toward the side of the friction plate set, the bulging portion of the clearance adjustment piston being received in the bulging portion of the engaging piston, and the engaging hydraulic chamber may be formed by the bulging portion of the engaging piston, and the bulging portion of the clearance adjustment piston received in the bulging portion of the engaging piston.

According to the aforementioned configuration, it is possible to keep the volume of the engaging hydraulic chamber substantially unchanged when the clearance adjustment piston is moved toward the side of the friction plate set. This makes it possible to form the engaging hydraulic chamber with a small size, as compared with a configuration, in which the volume of an engaging hydraulic chamber is increased. Forming the engaging hydraulic chamber with a small size is advantageous in engaging the friction plates with enhanced responsiveness, and in finely controlling the timing or the engaging force of an engaging operation.

Further, preferably, the brake device may be further provided with a retaining plate disposed axially on a side of the friction plate set opposite to the engaging piston; and a stopper member fixed to the clearance adjustment piston, and extending toward a side of the retaining plate. The stopper member may be abutted against the retaining plate when the clearance adjustment piston is moved toward the side of the friction plate set so as to restrict movement of the clearance adjustment piston at a position where the clutch clearance of a predetermined size is formed.

According to the aforementioned configuration, it is possible to securely restrict movement of the clearance adjustment piston with a relatively simplified configuration, without forming a groove portion for a seal member to mount the seal member, or forming a groove portion for a snap ring to mount the snap ring. Further, the aforementioned configuration is advantageous in improving productivity, as compared with a configuration, in which a groove portion for a seal member is formed in a clearance adjustment piston to mount the seal member, or a groove portion for a snap ring is formed to mount the snap ring.

INDUSTRIAL APPLICABILITY

As described above, according to the present invention, it is possible to reduce a sliding resistance between friction plates at the time of non-engagement. Therefore, the present invention is suitably applicable to the technical field of manufacturing a transmission brake device including an engaging piston and a clearance adjustment piston, and to vehicles mounted with the transmission brake device.

The invention claimed is:

1. A transmission brake device, comprising:

a friction plate set configured such that a plurality of rotation-side friction plates that are axially movably engaged with a predetermined rotary member, and a plurality of fixed-side friction plates that are axially movably engaged with a transmission case are alternately disposed;

an engaging piston disposed on an axial side of the friction plate set;

a clearance adjustment piston disposed on a side of the engaging piston opposite to the friction plate set, and configured to move the engaging piston toward the side of the friction plate set so as to adjust a clutch clearance;

a clearance adjustment hydraulic chamber configured to move the clearance adjustment piston toward the side of the friction plate set when a hydraulic pressure is supplied to the clearance adjustment hydraulic chamber;

an engaging hydraulic chamber configured to move the engaging piston toward the side of the friction plate set when a hydraulic pressure is supplied to the engaging hydraulic chamber,

a retaining plate disposed axially on a side of the friction plate set opposite to the engaging piston; and

a stopper member fixed to the clearance adjustment piston, and extending toward a side of the retaining plate, wherein

the transmission brake device includes a biasing member disposed between each adjacent pair of the fixed-side friction plates, the biasing member being configured to bias each adjacent pair of the fixed-side friction plates in directions away from each other, and

the biasing member distributes the clutch clearance in a gap between each adjacent pair of the fixed-side friction plates when a hydraulic pressure is supplied only to the clearance adjustment hydraulic chamber out of the clearance adjustment hydraulic chamber and the engaging hydraulic chamber,

the biasing member is circumferentially provided with a plurality of biasing portions for biasing each adjacent pair of the fixed-side friction plates in the directions away from each other, and

the engaging piston is provided with a bulging portion bulging toward the side of the friction plate set,

the clearance adjustment piston is provided with a bulging portion bulging toward the side of the friction plate set, the bulging portion of the clearance adjustment piston being received in the bulging portion of the engaging piston,

the engaging hydraulic chamber is formed by the bulging portion of the engaging piston, and the bulging portion of the clearance adjustment piston received in the bulging portion of the engaging piston, and

the stopper member is abutted against the retaining plate when the clearance adjustment piston is moved toward the side of the friction plate set so as to restrict movement of the clearance adjustment piston at a position where the clutch clearance of a predetermined size is formed.

2. A transmission brake device, comprising:

a friction plate set configured such that a plurality of rotation-side friction plates that are axially movably engaged with a predetermined rotary member, and a plurality of fixed-side friction plates that are axially movably engaged with a transmission case are alternately disposed;

an engaging piston disposed on an axial side of the friction plate set;

a clearance adjustment piston disposed on a side of the engaging piston opposite to the friction plate set, and configured to move the engaging piston toward the side of the friction plate set so as to adjust a clutch clearance;

a clearance adjustment hydraulic chamber configured to move the clearance adjustment piston toward the side of the friction plate set when a hydraulic pressure is supplied to the clearance adjustment hydraulic chamber;

an engaging hydraulic chamber configured to move the engaging piston toward the side of the friction plate set when a hydraulic pressure is supplied to the engaging hydraulic chamber,

a retaining plate disposed axially on a side of the friction plate set opposite to the engaging piston; and

a stopper member fixed to the clearance adjustment piston, and extending toward a side of the retaining plate, wherein

the transmission brake device includes a biasing member disposed between each adjacent pair of the fixed-side friction plates, the biasing member being configured to bias each adjacent pair of the fixed-side friction plates in directions away from each other, and

the biasing member distributes the clutch clearance in a gap between each adjacent pair of the fixed-side friction plates when a hydraulic pressure is supplied only to the clearance adjustment hydraulic chamber out of the clearance adjustment hydraulic chamber and the engaging hydraulic chamber,

the engaging piston is provided with a bulging portion bulging toward the side of the friction plate set,

the clearance adjustment piston is provided with a bulging portion bulging toward the side of the friction plate set, the bulging portion of the clearance adjustment piston being received in the bulging portion of the engaging piston,

the engaging hydraulic chamber is formed by the bulging portion of the engaging piston, and the bulging portion of the clearance adjustment piston received in the bulging portion of the engaging piston, and

the stopper member is abutted against the retaining plate when the clearance adjustment piston is moved toward the side of the friction plate set so as to restrict movement of the clearance adjustment piston at a position where the clutch clearance of a predetermined size is formed.

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