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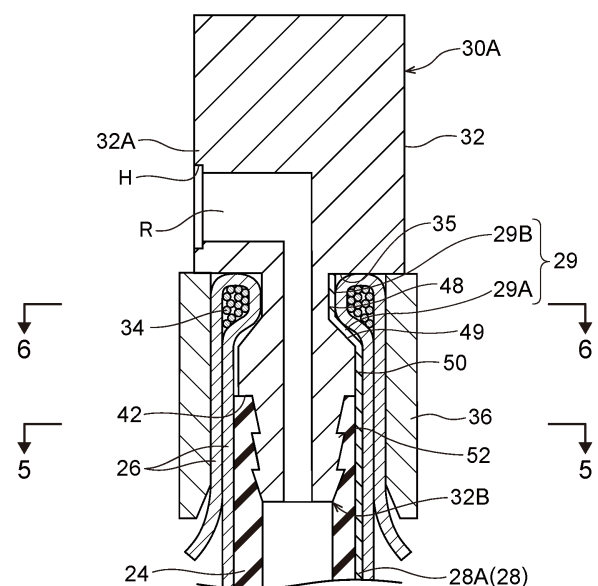
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(54) **HYDRAULIC ACTUATOR**

(57) A fluid pressure actuator 20 includes: a tube 24 that has a tubular shape, a sleeve 26 that covers the outer circumferential surface of the tube 24 and expands the tube in a radial direction while restricting extension of the tube in an axial direction by expansion of the tube, a pair of sealing members 32 at each of which an insertion part 32B including a tapered part 49 whose diameter becomes smaller toward a depth side of insertion is formed, and that seal tube end parts, a constraint member 28 that is provided from one side to another side of the pair of sealing members 32, is disposed so as to incline such that a constraint end part 29 is along the tapered part 49, resists the compression along the axial direction, and is deformable in an intersecting direction intersecting the axial direction, and a fixing member 36 that fixes the sleeve 26 and the constraint member 28 to the insertion part 32B from an outside of the sleeve 26 at a position meeting the constraint end part 29 of the constraint member 28.

FIG.4



Description

Technical Field

[0001] The present invention relates to a fluid pressure actuator.

Background Art

[0002] Japanese Patent Application Laid-Open (JP-A) No. 2021-088999 discloses a fluid pressure actuator that includes a tube that has a cylindrical shape and is expanded and contracted by a pressure of a fluid, a sleeve that is a structure formed by weaving fiber cords oriented in a predetermined direction and having stretchability, and that covers an outer circumferential surface of the tube, and sealing members that seal end parts in an axial direction of the tube, and that includes a constraint member provided from one end side to another end side in the axial direction inside the sleeve, and the constraint member resists compression along the axial direction and is deformable in a direction orthogonal to the axial direction.

SUMMARY OF INVENTION

Technical Problem

[0003] According to a configuration described in JP-A No. 2021-088999, it is concerned that, when a force acts on a distal end of the fluid pressure actuator, and particularly when a direction of a force received from an object is a direction intersecting the axial direction (when, for example, the object is lifted by setting the axial direction of the fluid pressure actuator as the horizontal direction), a position of the constraint member is readily shifted.

[0004] An object of the invention is to provide a fluid pressure actuator that reduces positional shift of a constraint member caused by action of a force.

Solution to Problem

[0005] A fluid pressure actuator according to a first aspect includes: a tube that has a tubular shape and expands and contracts according to a pressure of a fluid; a sleeve that covers an outer circumferential surface of the tube and expands the tube in a radial direction while restricting extension of the tube in an axial direction by the expansion of the tube; a pair of sealing members at each of which an insertion part into which each of tube end parts on one side and another side in the axial direction of the tube is inserted from a distal end side and that includes a tapered part whose diameter becomes smaller toward a depth side of the insertion, and that seal the tube end parts; a constraint member that is provided from one side to another side of the pair of sealing members on a radially inner side

of the sleeve, is disposed so as to incline such that a constraint end part is along the tapered part, resists the compression along the axial direction, and is deformable in an intersection direction intersecting the axial direction; and a fixing member that fixes the sleeve and the constraint member to the insertion part from an outside of the sleeve at a position meeting the constraint end part of the constraint member.

[0006] In the fluid pressure actuator according to the first aspect, the tapered part whose diameter becomes smaller toward the depth side of the insertion is formed at the insertion part of each of the sealing members that seal the tube end parts. The constraint end part of the constraint member is disposed so as to incline along the tapered part, and is fixed to the insertion part from the outside by the fixing member.

[0007] As described above, by fixing the constraint end part of the constraint member to the insertion part using a portion, too, having a smaller diameter than a portion of the fluid pressure actuator that expands and contracts, it is possible to reduce the force acting on the constraint end part in a circumferential direction.

[0008] In the fluid pressure actuator according to a second aspect, the sealing member includes a base end part that has a larger diameter than a diameter of the insertion part on a side opposite to a side of the insertion part into which the tube is inserted, and a small diameter part continuing from the tapered part and having a same diameter continuing in the axial direction is formed in the insertion part and at a boundary part with respect to the base end part, and the constraint end part is disposed to extend to the small diameter part.

[0009] According to the fluid pressure actuator according to the second aspect, the small diameter part is formed between the base end part and the insertion part of the sealing member, and the constraint end part is disposed to extend to the small diameter part, and can be stably fixed.

[0010] The fluid pressure actuator according to a third aspect is the fluid pressure actuator according to the second aspect in which the constraint end part is disposed in abutment with a step between the small diameter part and the base end part.

[0011] According to the fluid pressure actuator according to the third aspect, it is possible to prevent shift of the constraint end part in the axial direction.

[0012] The fluid pressure actuator according to a fourth aspect is the fluid pressure actuator according to the second or third aspect that further includes a locking wire that fixes the constraint end part to the small diameter part with the sleeve interposed therebetween.

[0013] According to the fluid pressure actuator according to the fourth aspect, it is possible to more firmly fix the constraint end part with the locking wire.

[0014] The fluid pressure actuator according to a fifth aspect is the fluid pressure actuator according to any one of the first to fourth aspects in which the constraint

end part is disposed in contact with the insertion part at the taper part.

[0015] According to the fluid pressure actuator according to the fifth aspect, the constraint end part is in contact with the insertion part without the tube interposed therebetween, and consequently can be more firmly fixed.

Advantageous Effects of Invention

[0016] According to the invention, it is possible to reduce positional shift of a constraint member caused by action of a force.

BRIEF DESCRIPTION OF DRAWINGS

[0017]

Fig. 1 is a plan view of a fluid pressure actuator according to an embodiment of the present disclosure.

Fig. 2 is an exploded perspective view of one end side in an axial direction of the fluid pressure actuator according to the embodiment of the disclosure.

Fig. 3 is a perspective view for describing a sealing member connector according to the embodiment of the disclosure.

Fig. 4 is a cross-sectional view of a connection portion between the sealing member connector and an actuator main body part according to the embodiment of the disclosure.

Fig. 5 is a cross-sectional view taken along line 5-5 in Fig. 4.

Fig. 6 is a cross-sectional view taken along line 6-6 in Fig. 4.

Fig. 7 is a cross-sectional view for describing an operation of the fluid pressure actuator according to the embodiment of the disclosure.

DESCRIPTION OF EMBODIMENTS

[0018] Hereinafter, an embodiment for implementing a technology of the disclosure will be described in detail with reference to the drawings.

[0019] Components and processing having the same operational effects and functions will be assigned the same reference numerals throughout the drawings, and redundant description may be omitted if appropriate. The disclosure is not limited to the following embodiment at all, and can be changed if appropriate and implemented within the scope of the object of the disclosure.

[0020] As shown in Fig. 1, a fluid pressure actuator 20 according to the embodiment of the disclosure includes an actuator main body part 22, a first sealing member 30A, and a second sealing member 30B.

[0021] As also shown in Fig. 2, the actuator main

body part 22 includes a tube 24, a sleeve 26, and a constraint member 28. The tube 24 has a cylindrical shape that can be expanded and contracted by elastic deformation, and expands and contracts in response to a pressure change of a fluid inside. An axial direction S of the tube 24 will be referred to as the "axial direction S". The tube 24 can be formed of an elastic material such as butyl rubber. Air can be used as the fluid to be supplied to the tube 24, and, in this case, the fluid pressure actuator 20 is a pneumatic actuator. When the fluid pressure actuator 20 is hydraulically driven, at least one selected from the group consisting of NBR (nitrile rubber) having high oil resistance, hydrogenated NBR, chloroprene rubber, and epichlorohydrin rubber is preferably used.

[0022] The sleeve 26 has a cylindrical shape that covers an outer circumference of the tube 24. The sleeve 26 is a structure formed by weaving fiber cords oriented in a predetermined direction, and having stretchability, and the oriented cords intersect in the axial direction S at a predetermined angle θ . The sleeve 26 has such a shape, and thereby causes pantograph deformation that changes the angle θ , and follows contraction and expansion while restricting contraction and expansion of the tube 24.

[0023] As the cords constituting the sleeve 26, fiber cords of aromatic polyamide (aramid fibers) or polyethylene terephthalate (PET) are preferably used. In this regard, the cords are not limited to such types of fiber cords, and may be cords of other high-strength fibers such as polyparaphenylene benzobisoxazole fibers (PBO).

[0024] The constraint member 28 is provided between the tube 24 and the sleeve 26. The constraint member 28 has an elongated plate shape, is disposed in a direction whose longitudinal direction goes along the axial direction S of the tube 24, covers a part of the outer circumference of the tube 24, and is disposed from one end to another end of the tube 24.

[0025] The constraint member 28 includes a constraint main body part 28A and constraint end parts 29. The constraint main body part 28A is a portion disposed along the axial direction S of the tube 24. The constraint end parts 29 are formed at both end parts of the constraint member 28. The constraint end part 29 has a bent shape having an inclined part 29A and a distal end part 29B. The inclined part 29A is bent so as to incline radially inward from the constraint main body part 28A toward the end part. The distal end part 29B continues from the inclined part 29A, and is extended in parallel to the constraint main body part 28A.

[0026] The constraint member 28 is formed of a material that is not expanded or contracted by pressurization, and is bendable and deformable in a direction in which the end parts approach each other. As the constraint member 28, a so-called leafspring can be used. The dimensions of the leafspring are determined according to a size of the fluid pressure actuator 20, a

required gripping force, and the like. A material of the leafspring is not particularly limited, and the material may be typically any material such as a metal such as stainless steel that readily bends and deforms and is robust against compression. Additionally, the leafspring may be formed of a thin plate of Carbon Fiber Reinforced Plastic (CFRP) or the like.

[0027] The first sealing member 30A includes a sealing member connector 32, a locking wire 34, and a fixing member 36.

[0028] As shown in Figs. 3 and 4, the sealing member connector 32 includes an integrally molded base end part 32A and insertion part 32B. The base end part 32A has a substantially rectangular parallelepiped shape having a larger diameter than an outer diameter of the tube 24, and the insertion part 32B is formed to extend in the axial direction S from a center on one end side of the base end part 32A. The insertion part 32B includes a small diameter part 48, a tapered part 49, a large diameter part 50, and a barb fitting part 52 in order from a base end part 32A side.

[0029] The barb fitting part 52 is formed to protrude from a distal end side of the insertion part 32B, and the tube 24 is inserted from the distal end of the barb fitting part 52. The barb fitting part 52 is formed as three stages of a tapered shape having a large diameter on a base end part 32A side. The large diameter part 50 is formed continuously on the base end part 32A side of the barb fitting part 52, and has a disk shape having a larger diameter than that of the barb fitting part 52. A step 42 is formed between the large diameter part 50 and the barb fitting part 52.

[0030] The tapered part 49 is formed continuously from the large diameter part 50 toward the base end part 32A side (a depth side of the insertion part 32B) of the large diameter part 50, and has a tapered shape whose diameter becomes smaller toward the base end part 32A side. An end part on the base end part 32A side of the tapered part 49 has a smaller diameter than that of a distal end of the barb fitting part 52.

[0031] The small diameter part 48 is formed between the tapered part 49 and the base end part 32A, and has the same diameter from the tapered part 49 to the base end part 32A. An outer diameter of the small diameter part 48 has a smaller diameter than that of the distal end of the barb fitting part 52. A step 35 is formed between the small diameter part 48 and the base end part 32A.

[0032] A metal such as stainless steel may be suitably used as the sealing member connector 32, and the metal is not limited to such a metal, and a hard plastic material or the like may be used.

[0033] As shown in Fig. 4, in the sealing member connector 32, a flow path R that extends in the axial direction S at a center part of the insertion part 32B as viewed from the axial direction S and communicates with a connection hole H on a side surface of the base end part 32A is formed. (See also Fig. 7). The connec-

tion hole H is connected with an unillustrated air supply hose, and compressed air is supplied to the flow path R.

[0034] The constraint end part 29 of the constraint member 28 is disposed at a position meeting the tapered part 49 and the small diameter part 48 of the sealing member connector 32 in the axial direction S. The constraint end part 29 is in direct contact with the insertion part 32B without the tube 24 interposed therebetween (see Fig. 4). The inclined part 29A of the constraint end part 29 is disposed such that an end part side inclines radially inward along the tapered part 49. The distal end part 29B of the constraint end part 29 extends from the inclined part 29A and is disposed along the small diameter part 48, and has an end surface that abuts the step 35 between the base end part 32A and the small diameter part 48.

[0035] The locking wire 34 has a ring shape formed by winding a wire a plurality of times, and is wound around an outer side of the sleeve 26 so as to sandwich the sleeve 26 between the locking wire 34 and the small diameter part 48. The sleeve 26 is folded back to an outer circumference with the locking wire 34 interposed therebetween. Thus, the sleeve 26 is locked to the sealing member connector 32. As the locking wire 34, a metal wire can be used.

[0036] The fixing member 36 is disposed so as to cover the insertion part 32B at an outer circumference of the actuator main body part 22. As shown in Fig. 5, the barb fitting part 52, the tube 24, the constraint main body part 28A of the constraint member 28, the sleeve 26 (before folding), and the sleeve 26 (after folding) are disposed at a portion corresponding to the barb fitting part 52 inside the fixing member 36. As shown in Fig. 6, the small diameter part 48, the distal end part 29B of the constraint member 28, the sleeve 26 (before folding), the locking wire 34, and the sleeve 26 (after folding) are disposed at a portion corresponding to the small diameter part 48 inside the fixing member 36.

[0037] By caulking the fixing member 36 radially inward, it is possible to fix the tube 24, the constraint member 28, and the sleeve 26 to the sealing member connector 32.

[0038] Next, an assembly procedure of the fluid pressure actuator 20 according to the present embodiment will be described.

<Assembly of Fluid Pressure Actuator 20>

[0039] As shown in Figs. 2 and 5, the first sealing member 30A and the actuator main body part 22 are assembled on one end side of the fluid pressure actuator 20 according to the present embodiment as follows.

[0040] First, the tube 24 is inserted into the insertion part 32B of the sealing member connector 32 until the one end of the tube 24 abuts the step 42. Next, the constraint member 28 is disposed such that the inclined part 29A of the constraint end part 29 is disposed along

the tapered part 49, the distal end part 29B of the constraint end part 29 is disposed along the small diameter part 48, and the end surface of the distal end part 29B abuts the step 35.

[0041] Next, the sleeve 26 covers an outer circumferential surface of the constraint member 28 while being hooked on the tube 24 and the base end part 32A of the sealing member connector 32, and the locking wire 34 is wound from the radially outer side of the sleeve 26 and attached at a position of the small diameter part 48.

[0042] Next, the sleeve 26 is folded back to the insertion part 32B of the sealing member connector 32 such that the locking wire 34 is disposed on an inner side, and the fixing member 36 is disposed from the radially outer side of the sleeve 26 to an end part of the small diameter part 48 of the insertion part 32B, and caulked and fixed. Thus, the tube 24, the constraint member 28, and the sleeve 26 are fixed to the sealing member connector 32 on one side in the axial direction S of the actuator main body part 22.

[0043] Next, similarly to the first sealing member 30A, the second sealing member 30B and the actuator main body part 22 are assembled on another side in the axial direction S.

[0044] According to the procedure, one side and another side of the tube 24 are sealed by the first sealing member 30A and the second sealing member 30B, and the fluid pressure actuator 20 is assembled.

[0045] Next, an operation of the fluid pressure actuator 20 in the disclosure will be described.

<Operation of Fluid Pressure Actuator 20>

[0046] As shown in Fig. 7, the fluid pressure actuator 20 is used such that the first sealing member 30A on the one end side is fixed and the second sealing member 30B on another end side is a free end.

[0047] When the compressed air flows in from the connection hole H, a pressure in the fluid pressure actuator 20 rises. When the internal pressure rises, the tube 24 elastically deforms and expands, the sleeve 26 causes pantograph deformation such that the angle θ increases, and a force acts in such a direction that a length of the actuator main body part 22 is shortened. At this time, an outer circumferential sidewall of the actuator main body part 22 on which the constraint member 28 is disposed is regulated from shortening, so that an outer circumferential wall of the actuator main body part 22 on a side on which the constraint member 28 is not disposed is shortened as viewed from the axial direction S. Thus, the constraint member 28 bends and deforms, and the entire actuator main body part 22 is curved as indicated by a two-dot chain line in Fig. 7.

[0048] In the disclosure, the constraint member 28 has a length in a width direction, and consequently is hardly bent in directions other than a plate thickness

direction, that is, a direction intersecting the axial direction S (hereinafter referred to as an "intersecting direction X") of the first sealing member 30A and the second sealing member 30B. In other words, as shown in Fig. 7, the constraint member 28 is bent in a direction toward an axial center of the tube 24.

[0049] By preparing a plurality of the fluid pressure actuators 20 curved in this manner, the plurality of fluid pressure actuators 20 can hold the object.

[0050] Next, functions and effects of the fluid pressure actuator 20 according to the disclosure will be described.

<Function and Effect>

[0051] In the fluid pressure actuator 20 according to the disclosure, the constraint end part 29 of the constraint member 28 is fixed to the insertion part 32B using the tapered part 49 and the small diameter part 48, too, having smaller diameters than that of the actuator main body part 22 that is a portion of the fluid pressure actuator 20 that expands and contracts. Thus, it is possible to reduce the force acting on the constraint end part 29 in the circumferential direction, and reduce the positional shift of the constraint member 28 caused by the action of the force.

[0052] The present embodiment has described the example where the constraint end part 29 includes the distal end part 29B disposed along the small diameter part 48, and the distal end part 29B is not necessarily necessary. As in the present embodiment, by providing the distal end part 29B and disposing the distal end part 29B along the small diameter part 48, it is possible to more stably fix the constraint member 28. By disposing the distal end part 29B in abutment with the step 35, it is possible to prevent shift of the constraint member 28 in the axial direction.

[0053] In the present embodiment, the constraint end part 29 is in direct contact with the insertion part 32B without the tube 24 interposed therebetween. Accordingly, it is possible to more firmly fix the constraint member 28 to the insertion part 32B as compared with the case in which the tube 24 is interposed.

[0054] Although the embodiment of the disclosure has been described above with reference to the accompanying drawings, it is obvious that a person having ordinary knowledge in the technical field to which the disclosure belongs can conceive various modifications or applications within the scope of the technical idea described in the claims, and it is naturally understood that these various modifications or applications also belong to the technical scope of the disclosure.

[0055] Japanese Patent Application No. 2023-208688 filed on December 11, 2023 is incorporated herein by reference in its entirety.

[0056] All documents, patent applications, and technical standards described in this specification are incorporated herein by reference to the same extent as that

in a case in which incorporation of individual documents, patent applications, and technical standards by reference is specifically and individually described.

Claims

1. A fluid pressure actuator comprising:

a tube that has a tubular shape and expands and contracts according to a pressure of a fluid; 10
 a sleeve that covers an outer circumferential surface of the tube and expands the tube in a radial direction while restricting extension of the tube in an axial direction by the expansion of the tube; 15
 a pair of sealing members at each of which an insertion part into which each of tube end parts on one side and another side in the axial direction of the tube is inserted from a distal end side and that includes a tapered part whose diameter becomes smaller toward a depth side of the insertion, and that seal the tube end parts; 20 25
 a constraint member that is provided from one side to another side of the pair of sealing members on a radially inner side of the sleeve, is disposed so as to incline such that a constraint end part is along the tapered part, resists the compression along the axial direction, and is deformable in an intersection direction intersecting the axial direction; and 30
 a fixing member that fixes the sleeve and the constraint member to the insertion part from an outside of the sleeve at a position meeting the constraint end part of the constraint member. 35

2. The fluid pressure actuator according to claim 1, wherein 40

the sealing member includes a base end part that has a larger diameter than a diameter of the insertion part on a side opposite to a side of the insertion part into which the tube is inserted, and a small diameter part continuing from the tapered part and having a same diameter continuing in the axial direction is formed in the insertion part and at a boundary part with respect to the base end part, and 45 50
 the constraint end part is disposed to extend to the small diameter part.

3. The fluid pressure actuator according to claim 2, wherein 55 the constraint end part is disposed in abutment with a step between the small diameter part and the base end part.

4. The fluid pressure actuator according to claim 2, further comprising a locking wire that fixes the constraint end part to the small diameter part with the sleeve interposed therebetween.

5. The fluid pressure actuator according to any one of claims 1 to 4, wherein the constraint end part is disposed in contact with the insertion part at the tapered part.

FIG.1

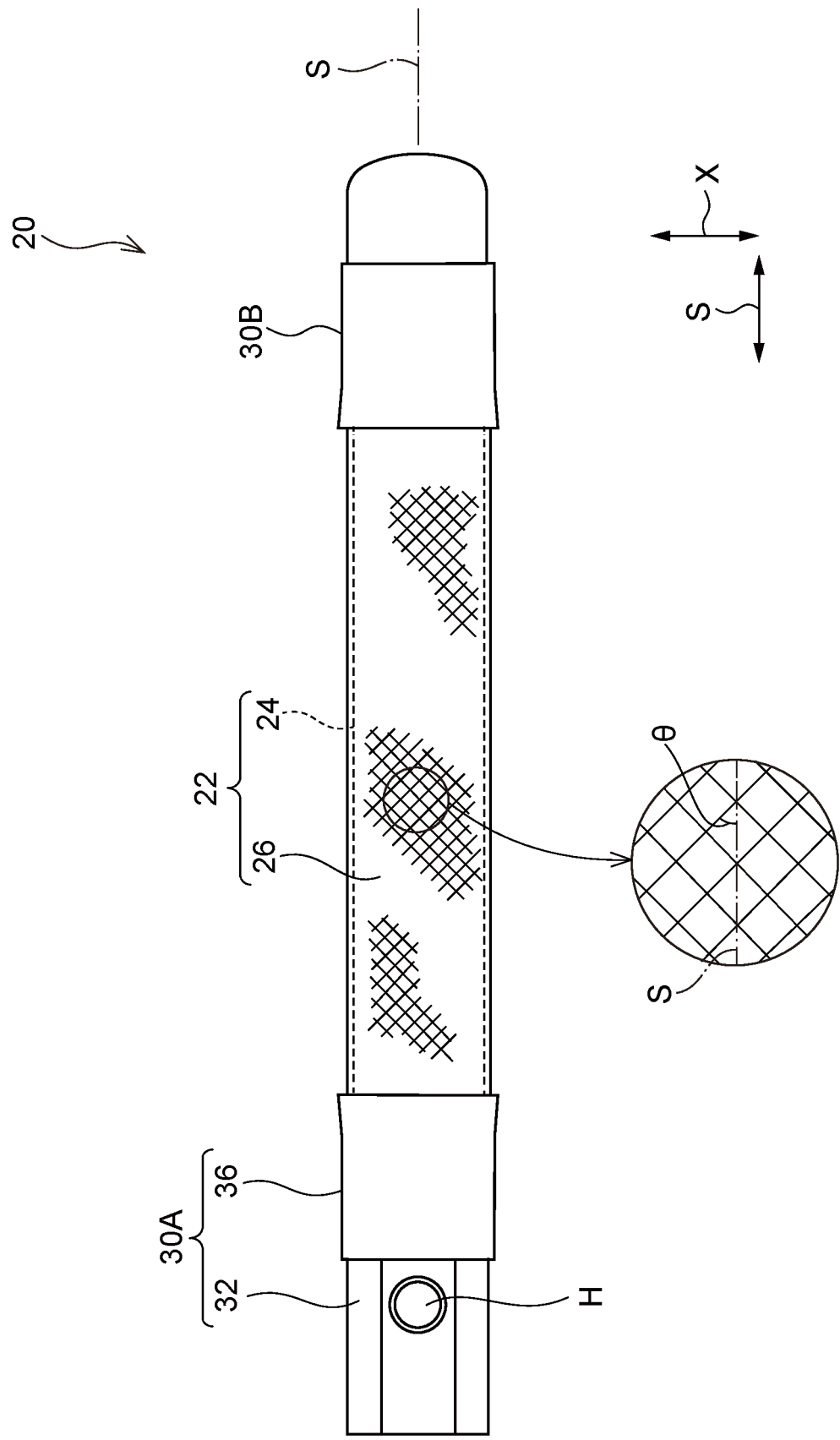


FIG.2

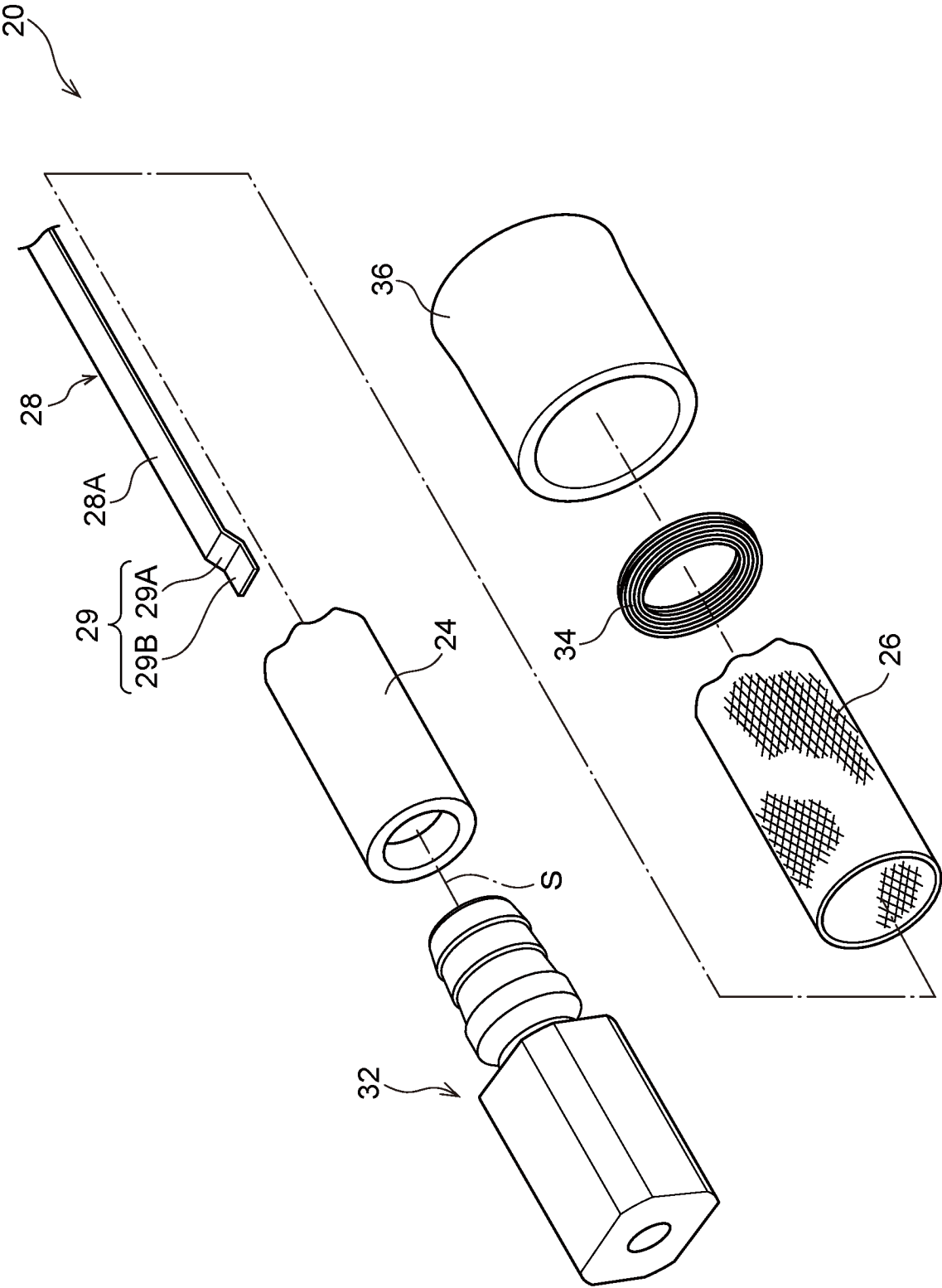


FIG.3

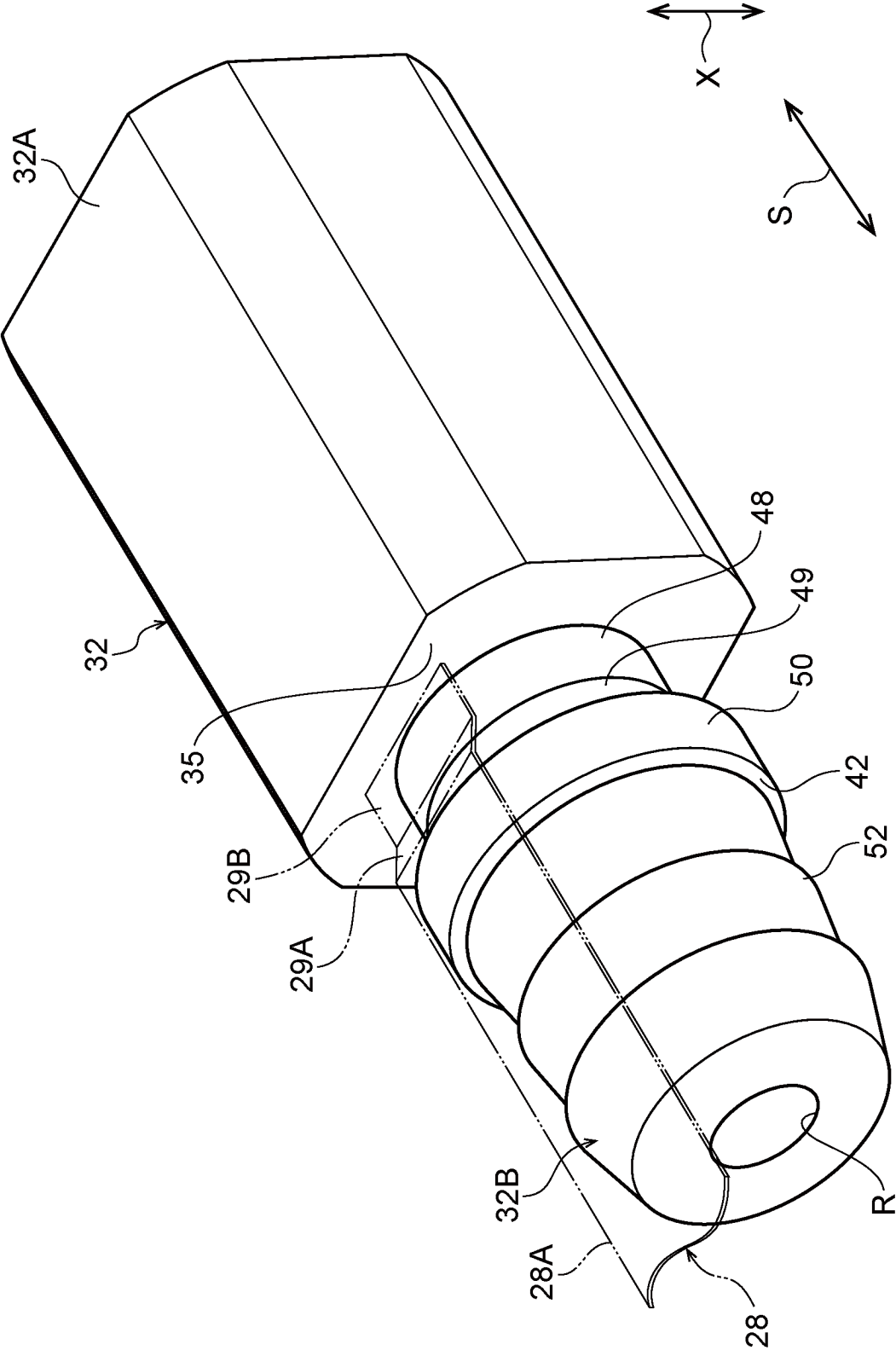


FIG.4

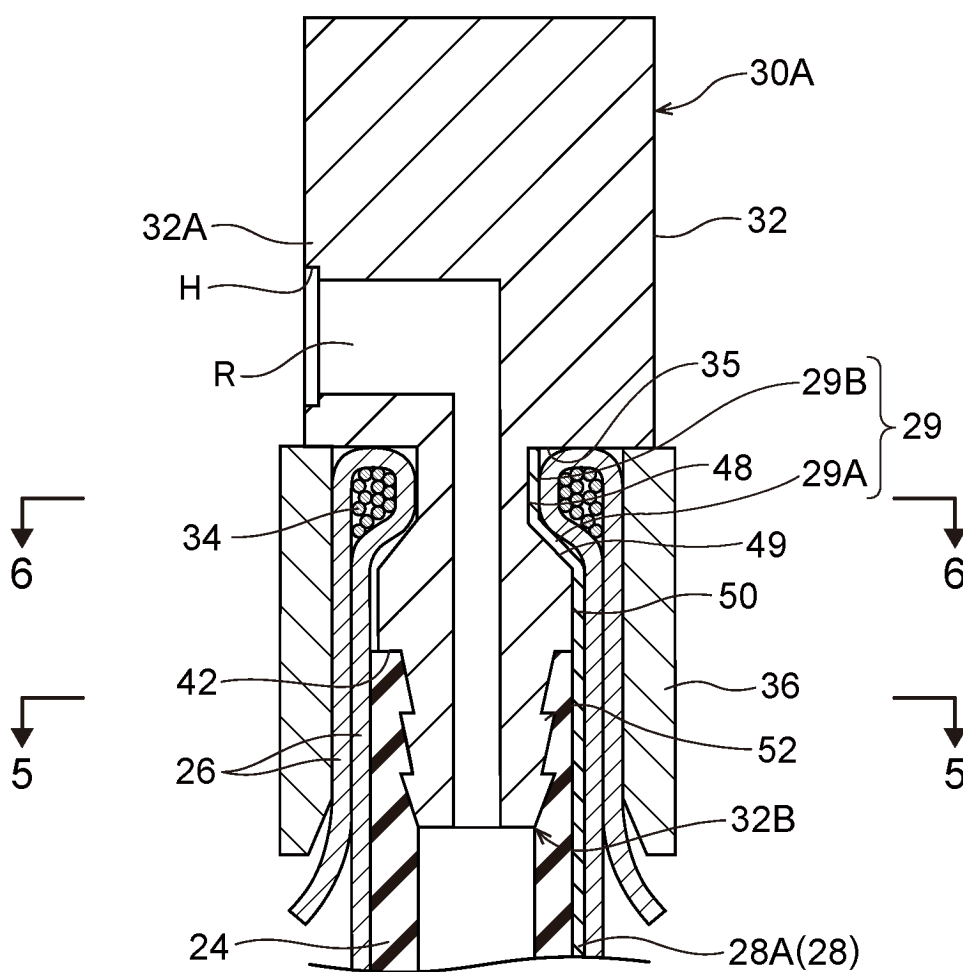


FIG.5

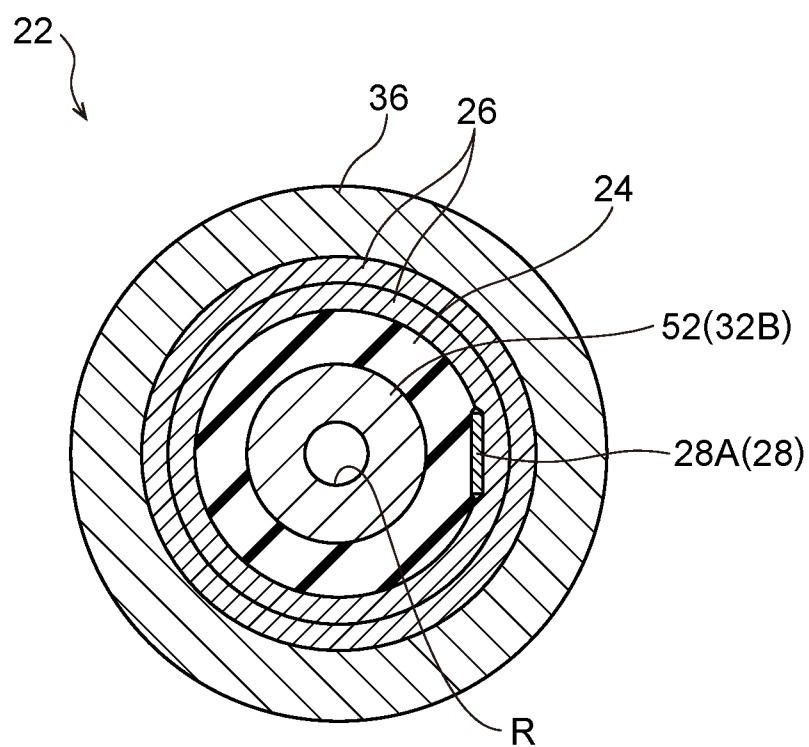


FIG.6

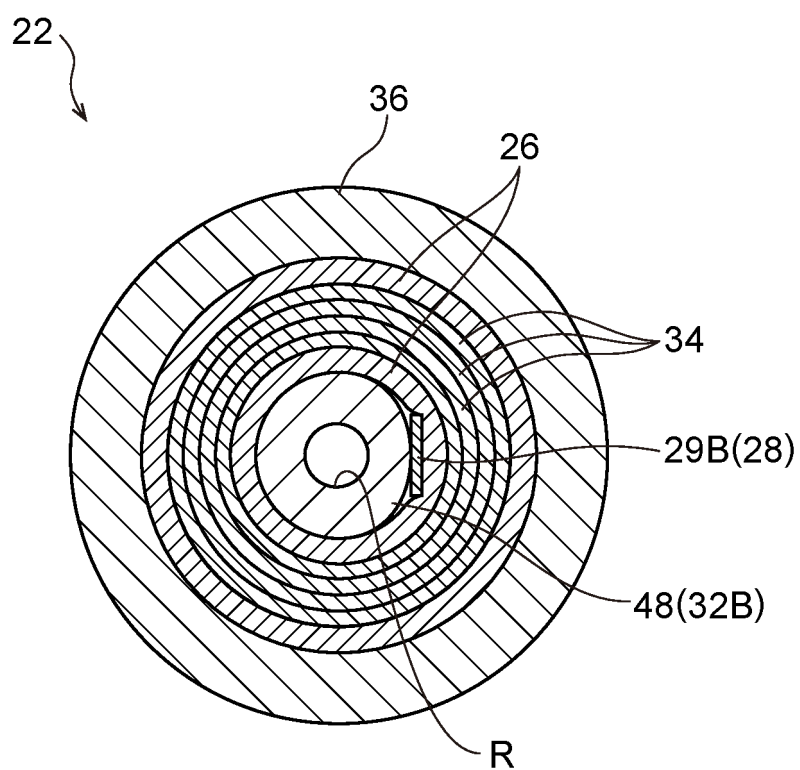
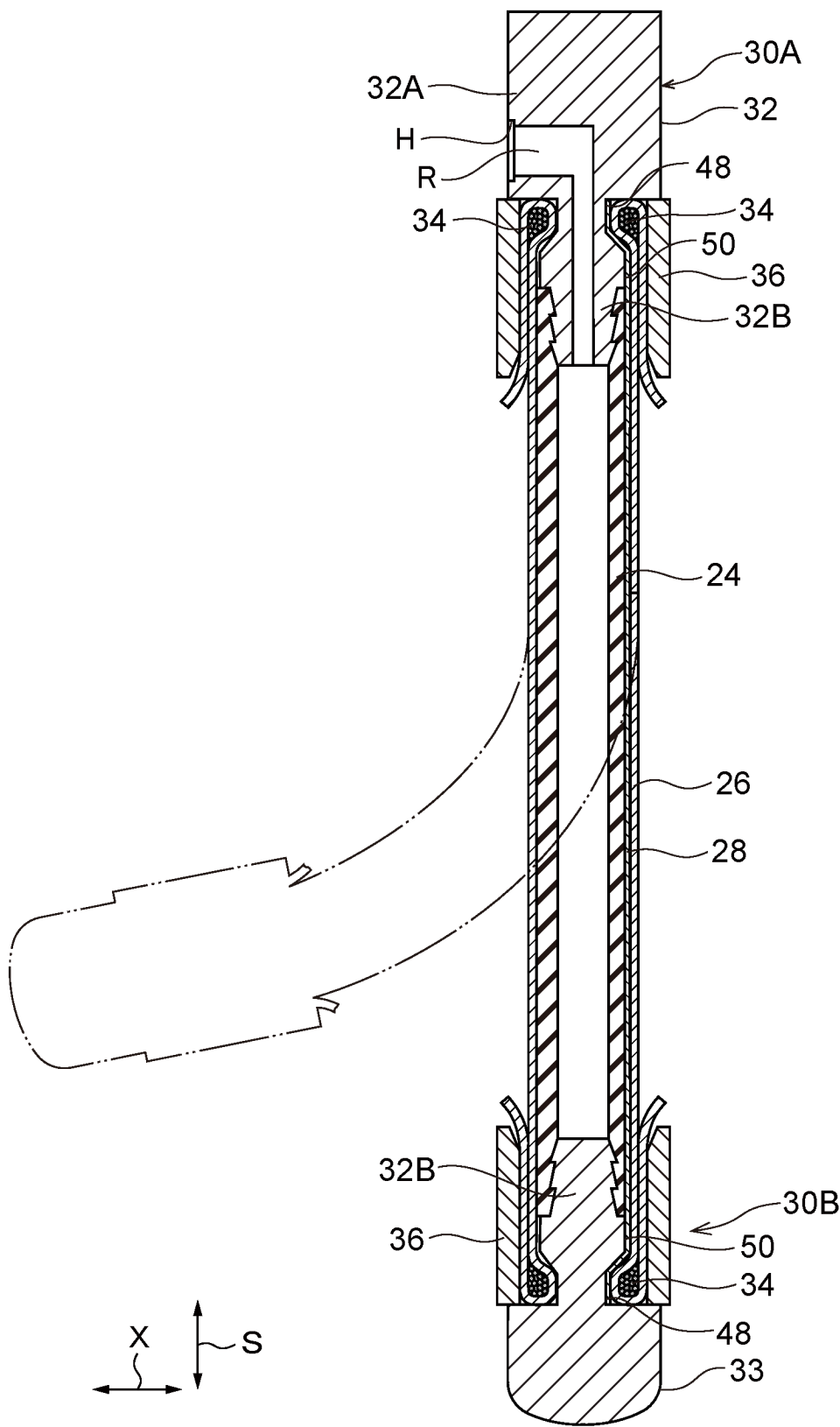


FIG.7



INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2024/042401

A. CLASSIFICATION OF SUBJECT MATTER**F15B 15/10**(2006.01)i

FI: F15B15/10 H

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)

F15B15/10

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

Published examined utility model applications of Japan 1922-1996
 Published unexamined utility model applications of Japan 1971-2025
 Registered utility model specifications of Japan 1996-2025
 Published registered utility model applications of Japan 1994-2025

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

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	JP 2023-131050 A (BRIDGESTONE CORPORATION) 21 September 2023 (2023-09-21) paragraphs [0012]-[0054], fig. 1-5	1-5
A	JP 2023-084851 A (BRIDGESTONE CORPORATION) 20 June 2023 (2023-06-20) paragraphs [0016]-[0065], fig. 1-5	1-5

☐ Further documents are listed in the continuation of Box C.☒ See patent family annex.

* Special categories of cited documents:

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Date of the actual completion of the international search

10 January 2025

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28 January 2025

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INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/JP2024/042401

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Patent document cited in search report				Publication date (day/month/year)	Patent family member(s)	Publication date (day/month/year)
JP	2023-131050	A		21 September 2023	(Family: none)	
JP	2023-084851	A		20 June 2023	EP 4446596 A1	
					paragraphs [0015]-[0064], fig. 1-5	
					CN 118339384 A	

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

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- JP 2023208688 A [0055]