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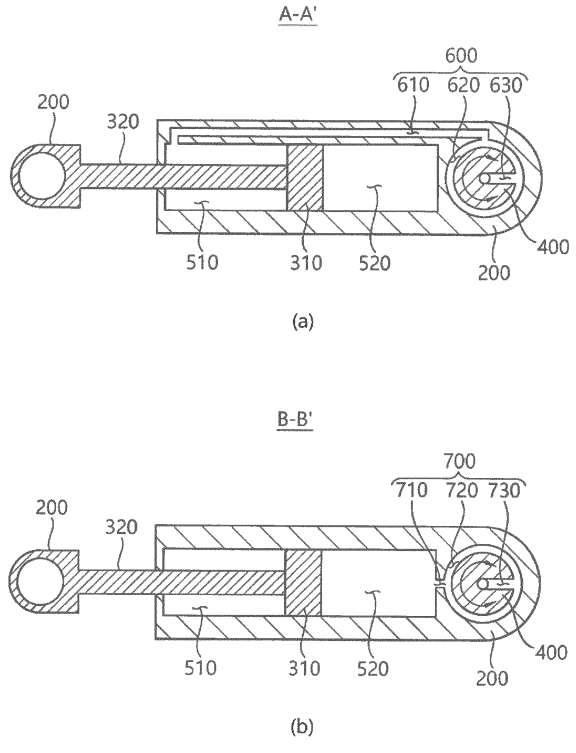
(54) LINEAR HYDRAULIC ACTUATOR

(57) The Present invention relates to a linear hydraulic actuator comprising: a housing having an inner space in which fluid can be accommodated; a piston formed so as to reciprocate in a longitudinal direction by receiving pressure from the fluid accommodated in the inner space; a piston rod connected to the piston by penetrating the housing and an inner flow path provided at an outer end of the housing or the piston rod so as to receive the fluid from a hinge part connected to the outside. The linear hydraulic actuator according to the present invention can transmit hydraulic pressure to the hinge part or a joint without a hose by using an actuator structure, such that the influence of elasticity of the hose ca be ignored, so as to increase control stiffness, thereby enabling precise and robust control performance to be ensured, an freedom of design to be increased by allowing the hose to be ignored during designing.

【Fig. 3】



EP 3 460 260 A1

Description

Technical Field

[0001] The present invention relates to a linear hydraulic actuator, and more particularly, to a linear hydraulic actuator that supplies a hydraulic pressure using a flow path formed within a structure thereof.

Background Art

[0002] A hydraulic actuator is an element that receives a hydraulic pressure to finally perform a movement among elements of a hydraulic pressure apparatus. Among them, a linear actuator includes a housing and a piston provided within the housing, and when a hydraulic pressure is applied to a bi-direction of the piston, the piston may perform a linear reciprocating motion.

[0003] In this case, a hydraulic pressure is supplied to a chamber within the housing in a state pressed by a hydraulic pressure pump, and in order to transfer a fluid, a tube is used from the pump to the actuator. As an actuator, in Korean Patent No. 891,552, a linear actuator having a hydraulic pressure tube is disclosed.

[0004] However, because an existing actuator transfers a fluid through a hose or a tube, when a hydraulic pressure operates, the hose or the tube is expanded by itself elasticity to have an influence on control rigidity and there is a problem that the hose or the tube may interfere a movement of the actuator and thus there may be a limitation upon designing.

Disclosure

Technical Problem

[0005] The present invention has been made in an effort to provide a linear hydraulic actuator for transferring a hydraulic pressure without a hose in order to solve a problem of a conventional linear hydraulic actuator.

Technical Solution

[0006] In accordance with an exemplary embodiment, a hydraulic actuator includes a housing having an internal space that may receive a fluid; a piston that receives a pressure from the fluid received at the internal space to perform a reciprocating motion in a length direction; a piston load that penetrates the housing to be connected to the piston; and an internal flow path that receives a fluid from a hinge portion connected to the outside at an external end portion of the housing or the piston load.

[0007] The hinge portion may be connected to a connection pin inserted in a orthogonal direction to a length direction of the actuator, and the internal flow path may be connected to a connection pin flow path formed in the connection pin in order to receive a fluid through the connection pin.

[0008] The connection flow path may be formed in a rotation direction in a connection portion of the connection pin flow path and the internal flow path in order to connect a flow path when the connection pin rotates.

[0009] The connection flow path may be formed between an inner surface of the hinge portion and an outer surface of the connection pin. The connection flow path may include a first cavity and a second cavity formed in a ring shape at an inner surface of the hinge portion.

[0010] The first cavity and the second cavity each may be separated at a predetermined distance in order to form an independent fluid path, and the hydraulic actuator may further include a first sealing member for preventing a fluid from being leaked between the first cavity and the second cavity.

[0011] The hydraulic actuator may further include second sealing members provided at the outside of a length direction of each of the first cavity and the second cavity in order prevent the fluid from being leaked in a length direction of the connection pin from the first cavity or the second cavity when the connection pin is fastened.

[0012] The internal space may be divided into a first chamber and a second chamber by the piston, and the internal flow path may include a first internal flow path and a second internal flow path formed in a length direction from the hinge portion in order to supply the fluid to each of the first chamber and the second chamber.

[0013] One side of the first internal flow path may be connected to the first cavity and be formed in a length direction within the housing, and the other side thereof may be connected to the first chamber, and one side of the second flow path may be connected to the second chamber and be formed in a length direction within the housing, and the other side thereof may be connected to the second chamber.

[0014] The hydraulic actuator may further include a wear ring provided at a periphery of the first cavity and the second cavity between the connection pin and the hinge portion in order to support a load of a length direction operating to the actuator.

[0015] In accordance with another exemplary embodiment, a hydraulic actuator includes a housing having an internal space that may receive a fluid; a piston that receives a pressure from the fluid received at the internal space to perform a reciprocating motion in a length direction; a hinge portion configured at an external end portion of the housing; a connection pin inserted into the hinge portion to be rotated; and a flow path formed through the connection pin, the hinge portion, and the housing such that the fluid is supplied to the internal space or is returned from the internal space.

[0016] The internal space may be divided into a first chamber and a second chamber by the piston, and the flow path may include: a first flow path that fluidically communicates with the first chamber and the outside; and a second flow path that fluidically communicates with the second chamber and the outside.

[0017] The first flow path and the second flow path may

include a first cavity and a second cavity, respectively, configured with an inner surface of the hinge portion and an outer surface of the connection pin in order to fluidically communicate even when the connection pin rotates within the hinge portion.

[0018] The first cavity and the second cavity are formed in a ring shape between an inner surface of the hinge portion and an outer surface of the connection pin.

[0019] The hydraulic actuator may further include second sealing members spaced from the first cavity and the second cavity in an axial direction of the connection pin in order to prevent the fluid from being leaked to the outside when the connection pin rotates.

Advantageous Effects

[0020] Because a linear hydraulic actuator according to an exemplary embodiment of the present invention may transfer a hydraulic pressure to a hinge portion or a joint using an actuator structure without a hose, an influence of elasticity of the hose may be ignored and thus control rigidity is enhanced and a precise and robust control performance can be thus secured, and upon designing, a hose may be ignored and thus the degree of freedom of a design can be enhanced.

Description of Drawings

[0021]

FIG. 1 is a perspective view illustrating a linear hydraulic actuator according to a first exemplary embodiment.

FIG. 2 is a diagram illustrating an internal flow path of FIG. 1.

FIG. 3 is a cross-sectional view illustrating the linear hydraulic actuator taken along line A-A' and B-B' of FIG. 1.

FIG. 4 is a cut-away perspective view illustrating a hinge portion taken along line C-C' of FIG. 1.

FIG. 5 is a cross-sectional view illustrating the linear hydraulic actuator taken along line C-C' of FIG. 1.

FIG. 6 is a conceptual diagram illustrating a linear hydraulic actuator according to a second exemplary embodiment.

FIG. 7 is a cross-sectional view illustrating the linear hydraulic actuator taken along line A-A' and B-B' of a second exemplary embodiment.

FIG. 8 is a cross-sectional view illustrating a linear hydraulic actuator according to a third exemplary embodiment.

Mode for Invention

[0022] Hereinafter, a linear hydraulic actuator according to an exemplary embodiment of the present invention will be described in detail with reference to the accompanying drawings. In a description of the following exemplary embodiment, a name of each constituent element may be referred to as a different name in the art. However, when the constituent elements have functional similarity and identity, even if a changed exemplary embodiment is adapted, the constituent elements may be regarded as equivalent elements. Further, for convenience of a description, a reference numeral is added to each constituent element. However, contents shown on a drawing having these reference numerals do not limit a range of each constituent element to a range within the drawing. Similarly, even if an exemplary embodiment is adapted in which a constituent element on a drawing is partially changed, when the constituent elements have functional similarity and identity, the constituent elements may be regarded as equivalent elements. Further, when the constituent element is recognized as a constituent element that should be naturally included in a level of a person of ordinary skill in the art, a detailed description thereof will be omitted.

[0023] FIG. 1 is a perspective view illustrating a linear hydraulic actuator according to a first exemplary embodiment.

[0024] As shown in FIG. 1, the linear hydraulic actuator according to an exemplary embodiment of the present invention may include a housing 100, a piston 310, a piston load 320, a hinge portion 200, a connection pin 400, and a flow path. In the linear hydraulic actuator, a location of the piston 310 is changed according to a supply direction of a hydraulic pressure, and the piston load 320 may finally linearly move. The hinge portion 200 is provided at each of both ends of the linear hydraulic actuator, i.e., an end portion of the housing 100 and an end portion of the piston load 320, and the linear hydraulic actuator is connected to an external structure or a link to transfer power to the outside.

[0025] The housing 100 forms an entire external form of the actuator and is configured in a long pillar shape in an operation direction of the actuator. At the inside of the housing 100, a cylinder-shaped chamber is provided such that the piston 310 performs a linear reciprocating motion. In this case, a first chamber 510 and a second chamber 520 may be divided by the piston 310. At the outside thereof, the hinge portion 200 for connecting with the outside at one side may be provided.

[0026] The piston 310 is configured to receive a pressure from a fluid within the chamber to generate a force. The piston 310 may have a cross-section of a cylinder shape, and in order to prevent a fluid from being leaked between each chamber within the housing 100 and to reduce a friction upon moving, a seal complex may be provided at an edge of a circumferential direction of the piston 310.

[0027] The piston load 320 is provided to operate a force generated in the piston 310 to the outside. One side of the piston load 320 is connected to the piston 310 and is installed to penetrate the housing 100 in a length direction, and the hinge portion 200 may be provided such that the other side of the piston load 320 is connected to

an external structure. In a lower end cap portion in which the piston load 320 and the housing 100 contact, a seal kit may be provided not to leak a fluid within the chamber. A general configuration of the housing 100 and the piston 310 is a widely used configuration and therefore a detailed description thereof may be omitted.

[0028] The connection pin 400 is inserted into the hinge portion 200 provided in the housing 100 to be connected to an external structure, and is inserted into the hinge portion 200 in a pin form and is configured to rotate in a connection portion when an entire length is changed according to an operation of the actuator to perform a smooth mechanical movement. A connection pin flow path 630, 730 may be provided within the connection pin 400 and this will be described in detail later.

[0029] In order to receive a fluid from the outside without a hose to supply the fluid to the chamber, a flow path that supplies a hydraulic pressure is formed within the housing 100. Such an internal flow path will be described in detail hereinafter.

[0030] FIG. 2 is a diagram illustrating an internal flow path of FIG. 1, and FIG. 3 is a cross-sectional view illustrating the linear hydraulic actuator taken along line A-A' and B-B' of FIG. 1.

[0031] Referring to FIG. 2, the internal flow path may include a first flow path 600 that forms a path for fluidical communication of the first chamber 510 and the outside and a second flow path 700 that forms a path for fluidical communication of the second chamber 520 and the outside. The first flow path 600 and the second flow path 700 each form a independent path of a fluid, and a hydraulic pressure may be selectively transferred by a valve provided at the outside of the actuator.

[0032] The first flow path 600 may include a first internal flow path 610, a first cavity 620, and a first connection pin flow path 630, and the second flow path 700 may include a second internal flow path 710, a second cavity 720, and a second connection pin flow path 730 to correspond thereto.

[0033] Here, a flow of a fluid entered from the outside may be performed in order of a connection pin flow path, a cavity, an internal flow path, and a chamber. Upon operating the actuator the first flow path 600 and the second flow path 700, a fluid flows in an opposite direction. That is, when a fluid increases to the first chamber 510, the piston 310 moves toward the second chamber 520, and a fluid received in the second chamber 520 is discharged to the outside. In this case, a fluid is discharged to the outside in order opposite to the foregoing order.

[0034] When specifically describing a flow path, the first connection pin flow path 630 and the second connection pin flow path 730 are extended in an axial direction from a central portion of the connection pin 400 to be formed to a predetermined length. In this case, the first connection pin flow path 630 and the second connection pin flow path 730 are not directly connected to be each extended in a radial direction, and both sides communicate with the outside of the connection pin 400, respectably. One side of each each connection pin flow path 630, 730 communicates with the outside of the actuator, and the other side thereof communicates with the first cavity 620 and the second cavity 720, respectably to be described. Although not shown in the drawing, a connection pin flow path 630, 730 are extended in an axial direction to be connected to the outside or when the connection pin 400 is fixed not to rotate to the outside, the flow path of the connection pin 400 may be extended in an axial direction to be connected to a flow path of the outside.

[0035] The first cavity 620 and the second cavity 720 may be a space formed by an outer surface of the connection pin 400 and an inner surface of the hinge portion 200. The first cavity 620 and the second cavity 720 become a ring-shaped space in a rotation direction at an outer surface of the connection pin 400 in order to enclose the connection pin 400 to each be a connection flow path. The first cavity 620 and the second cavity 720 each are disposed to secure an independent fluid path at a distance separated by a predetermined distance in an axial direction of the connection pin 400. In this case, for a smooth movement of a fluid, a concave groove may be formed along an inner surface of the hinge portion 200. Therefore, a flow cross-sectional area may be secured to smoothly move a fluid of a predetermined flow rate or more.

[0036] The first connection pin flow path 630 and the second connection pin flow path 730 may be connected to the first cavity 620 and the second cavity 720, respectively. That is, a point communicated in an axial direction in the first connection pin flow path 630 and the second connection pin flow path 730 may be a point on the first cavity 620 and the second cavity 720.

[0037] The first internal flow path 610 and the second internal flow path 710 connect the first cavity 620 and the second cavity 720; and the first chamber 510 and the second chamber 520, respectively. The first internal flow path 610 is formed from an inside of the hinge portion 200 so as to be connected to the first cavity 620, is formed from one point of the first cavity 620 in a radial direction of the hinge portion 200, and is extended by a predetermined distance in a length direction of the housing 100. Thereafter, the first internal flow path 610 may be formed in a radial direction of the housing 100 to be connected to the first chamber 510 within the housing 100. The second internal flow path 710 is formed within the housing 100 so as to connect the second cavity 720 and the second chamber 520. Even when a volume of the first chamber 510 and the second chamber 520 is changed according to a movement of the piston 310, a fluid should be continuously supplied into or returned from the first internal flow path 610 and the second internal flow path 710, and thus the first internal flow path 610 and the second internal flow path 710 are connected to the first chamber 510 and the second chamber 520, respectively, in consideration of a stroke of the piston 310. That is, the first internal flow path 610 and the second internal flow path

710 may be connected to the opposite end portion side of the first chamber 510 and the second chamber 520. However, although not shown in the drawing, the first internal flow path 610 and the second internal flow path 710 may include various shapes and paths according to a shape and a connection pipe of the hinge portion 200 and a cylinder and a shape of the housing 100.

[0038] In order to be a independent flow path, the first flow path 600 and the second flow path 700 may be formed at the inside of the housing 100, the hinge portion 200, and the inside of the connection pin 400. In this case, because the first connection pin flow path 630 and the second connection pin flow path 730 are formed in a radial direction of the connection pin 400, even if the connection pin 400 rotates, the first connection pin flow path 630 and the second connection pin flow path 730 may be continuously connected to the first cavity 620 and the second cavity 720.

[0039] Referring again to FIG. 3, a portion of the first connection pin flow path 630, the first cavity 620, the first internal flow path 610, and the housing 100 are shown. As shown in FIG. 3a, even if the connection pin 400 rotates in an arrow direction, a first flow path 600 is formed in which the first connection pin flow path 630 formed in a radial direction is continuously connected to the first cavity 620 and thus the first connection pin flow path 630 and the first chamber 510 are finally connected. Further, FIG. 3b illustrates a configuration in which the second connection pin flow path 730 is connected to the second chamber 520 through the second cavity 720, and even if the connection pin 400 rotates, the second flow path 700 may continuously be connected to the second chamber 520.

[0040] Hereinafter, the first cavity 620, the second cavity 720, a first sealing member 810, and second sealing members 820 will be described in detail with reference to FIGS. 4 and 5.

[0041] FIG. 4 is a cut-away perspective view illustrating a hinge portion 200 taken along line C-C' of FIG. 1, and FIG. 5 is a cross-sectional view illustrating the linear hydraulic actuator taken along line C-C' of FIG. 1.

[0042] As shown in FIGS. 4 and 5, the first cavity 620 and the second cavity 720 maybe separated by a predetermined distance in an axial direction of the connection pin 400. In this case, if a hydraulic fluid is leaked in an axial direction of the connection pin 400, a loss of a pressure and a fluid may occur, and a control error may occur. Therefore, in order to prevent a fluid from flow between the first cavity 620 and the second cavity 720, the first sealing member 810 may be provided. A type of the first sealing member 810 may be selected according to a fluid kind, and as the first sealing member 810 is formed in a ring shape, even if the connection pin 400 rotates, the first sealing member 810 prevents a fluid from moving in an axial direction.

[0043] In order to prevent a fluid from being leaked to the outside of the hinge portion 200, the second sealing members 820 are provided at the outside of each of the first cavity 620 and the second cavity 720, respectably. Each second sealing member 820 prevents a fluid from being leaked in an axial direction, as in the first sealing member 810 and may be configured to seal even when the connection pin 400 rotates.

[0044] A wear ring 900 is provided within the hinge portion 200 and is configured to prevent the hinge portion 200 or the connection pin 400 from being damaged by a friction when the connection pin 400 rotates. Further, when a force operates in a length direction of the actuator, i.e., a radial direction of the connection pin 400, the wear ring 900 is provided to uniformly support. A plurality of wear rings 900 may be provided to be separated by a predetermined gap in a length direction of the connection pin 400. Such a wear ring 900 is a generally much used configuration and therefore a detailed description of a material and a shape thereof may be omitted.

[0045] Hereinafter, a second exemplary embodiment of the present invention will be described in detail with reference to FIGS. 6 and 7.

[0046] The present exemplary embodiment may include constituent elements corresponding to those of the foregoing exemplary embodiment, and in order to avoid a repeated description, a detailed description thereof is omitted, and only dissimilar constituent elements will be described.

[0047] FIG. 6 is a conceptual diagram illustrating a linear hydraulic actuator according to a second exemplary embodiment, and FIG. 7 is a cross-sectional view illustrating the linear hydraulic actuator taken along line A-A' and B-B' of a second exemplary embodiment.

[0048] As shown in FIGS. 6 and 7, the connection pin 400 is connected to the hinge portion 200 provided toward the piston load 320, and a configuration is shown that supplies a fluid to each chamber through the first internal flow path 610 and the second internal flow path 710 formed within the piston load 320.

[0049] In this case, a distance is determined in which the piston load 320 may perform a reciprocating motion, and a fluid should be supplied to a location of an end portion. Therefore, the first internal flow path 610 communicates with the first chamber 510 through the the piston 310, and the second internal flow path 710 passes through the piston 310 to communicate with the second chamber 520 side.

[0050] In this case, the first internal flow path 610 and the second internal flow path 710 may be extended in a length direction from the hinge portion 200 of the piston load 320 through the piston 310 and be separated by a predetermined distance in a thickness direction.

[0051] Even if the connection pin 400 rotates within the hinge portion 200, for continuous inflow and outflow of a fluid, cavities 620 and 720 and connection pin flow paths 630 and 730 may be provided, as in a first exemplary embodiment.

[0052] FIG. 8 is a cross-sectional view illustrating a linear hydraulic actuator according to a third exemplary embodiment. The present exemplary embodiment may in-

clude constituent elements corresponding to those of the foregoing exemplary embodiment, and in order to avoid a repeated description, a detailed description thereof is omitted, only dissimilar constituent elements will be described.

[0053] As shown in FIG. 8, in the present exemplary embodiment, the first cavity 620 and the second cavity 720 are formed in an arc shape instead of a ring shape when viewed from an axial direction of the connection pin 400. In the linear actuator, a relative rotation angle of the fixed hinge portion 200 may be 360° or less, and even when a stroke of the piston 310 is maximum-minimum, the hinge portion 200 moves only a predetermined angle θ. Therefore, because the connection pin 400 rotates within a predetermined angle, a cavity is formed to correspond to a predetermined angle θ and thus even when the connection pin 400 is rotating, the cavity may continuously fluidically communicate. In this case, the connection pin 400 is fixed to an external structure, and a flow path of the connection pin 400 formed in a radial direction moves only within an angle in which a cavity is formed when the actuator drives.

[0054] As described above, because a linear hydraulic actuator according to the present invention is configured to receive a hydraulic pressure from the hinge portion 200 and the connection pin 400, an influence of elasticity of a hose may be ignored and thus by enhancing control rigidity, a precise and robust control performance can be secured, and upon designing, a hose may be ignored and thus the degree of freedom of a design can be enhanced.

Claims

1. A hydraulic actuator, comprising:

a housing having an internal space that may receive a fluid;
a piston that receives a pressure from the fluid received at the internal space to perform a reciprocating motion in a length direction;
a piston load that penetrates the housing to be connected to the piston; and
an internal flow path that receives a fluid from a hinge portion connected to the outside at an external end portion of the housing or the piston load,
wherein the hinge portion comprises a connection flow path formed in a rotation direction in order to receive the supply of the fluid.

2. The hydraulic actuator of claim 1, wherein the hinge portion is connected to a connection pin inserted in an orthogonal direction to a length direction of the actuator, and
the internal flow path is connected to a connection pin flow path formed in the connection pin in order to receive a fluid through the connection pin.

3. The hydraulic actuator of claim 2, wherein the connection flow path is formed in a rotation direction in a connection portion of the connection pin flow path and the internal flow path in order to connect a flow path when the connection pin rotates.

4. The hydraulic actuator of claim 3, wherein the connection flow path is formed between an inner surface of the hinge portion and an outer surface of the connection pin.

5. The hydraulic actuator of claim 3, wherein the connection flow path comprises a first cavity and a second cavity formed in a ring shape at an inner surface of the hinge portion.

6. The hydraulic actuator of claim 5, wherein the first cavity and the second cavity each are separated at a predetermined distance in order to form an independent fluid path, and
wherein the hydraulic actuator further comprises a first sealing member for preventing a fluid from being leaked between the first cavity and the second cavity.

7. The hydraulic actuator of claim 6, further comprising second sealing members provided at the outside of a length direction of each of the first cavity and the second cavity in order prevent the fluid from being leaked in a length direction of the connection pin from the first cavity or the second cavity when the connection pin is fastened.

8. The hydraulic actuator of claim 6, wherein the internal space is divided into a first chamber and a second chamber by the piston, and
the internal flow path comprises a first internal flow path and a second internal flow path formed in a length direction from the hinge portion in order to supply the fluid to each of the first chamber and the second chamber.

9. The hydraulic actuator of claim 8, wherein one side of the first internal flow path is connected to the first cavity and is formed in a length direction within the housing, and the other side thereof is connected to the first chamber, and
Wherein one side of the second flow path is connected to the second chamber and is formed in a length direction within the housing, and the other side thereof is connected to the second chamber.

10. The hydraulic actuator of claim 6, further comprising a wear ring provided at a periphery of the first cavity and the second cavity between the connection pin and the hinge portion in order to support a load of a length direction operating to the actuator.

11. A hydraulic actuator, comprising:

a housing having an internal space that receive a fluid;
a piston that receives a pressure from the fluid received at the internal space to perform a reciprocating motion in a length direction;
a hinge portion configured at an external end portion of the housing;
a connection pin inserted into the hinge portion to be rotated; and
a flow path formed through the connection pin, the hinge portion, and the housing such that the fluid is supplied to the internal space or is returned from the internal space.

12. The hydraulic actuator of claim 11, wherein the internal space is divided into a first chamber and a second chamber by the piston, and
wherein the flow path comprises:

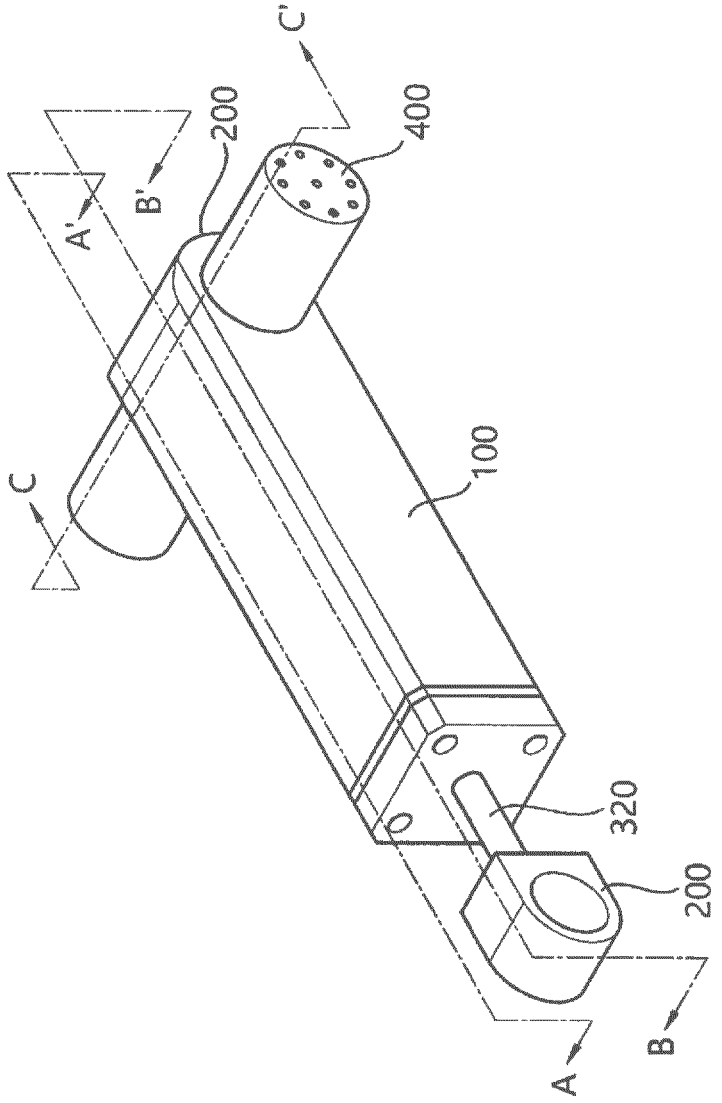
a first flow path that fluidically communicates with the first chamber and the outside; and
a second flow path that fluidically communicates with the second chamber and the outside.

13. The hydraulic actuator of claim 12, wherein the first flow path and the second flow path comprise a first cavity and a second cavity, respectively, configured with an inner surface of the hinge portion and an outer surface of the connection pin in order to fluidically communicate when the connection pin rotates within the hinge portion.

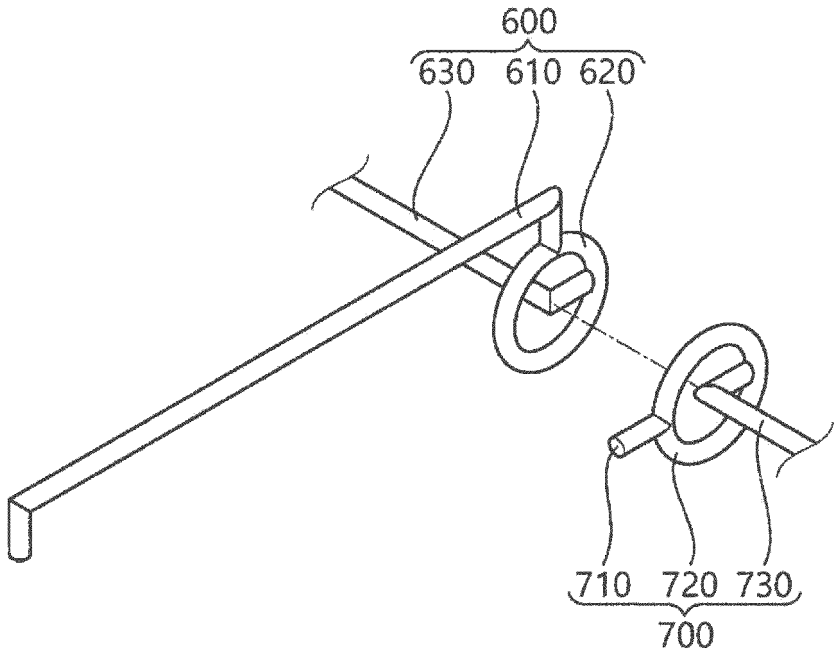
14. The hydraulic actuator of claim 13, wherein the first cavity and the second cavity are formed in a ring shape between an inner surface of the hinge portion and an outer surface of the connection pin.

15. The hydraulic actuator of claim 14, further comprising second sealing members spaced from the first cavity and the second cavity in an axial direction of the connection pin in order to prevent the fluid from being leaked to the outside when the connection pin rotates.

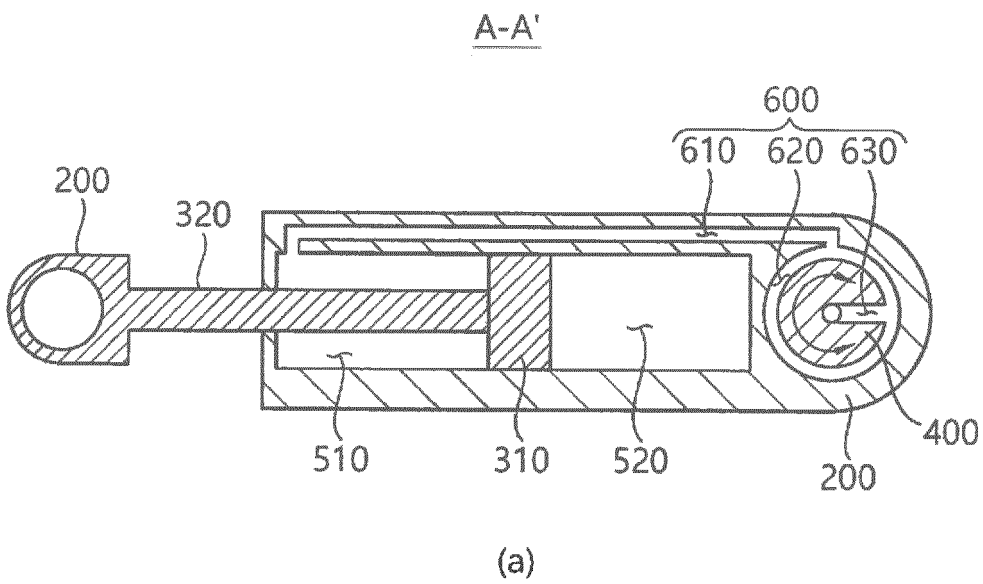
【Fig. 1】



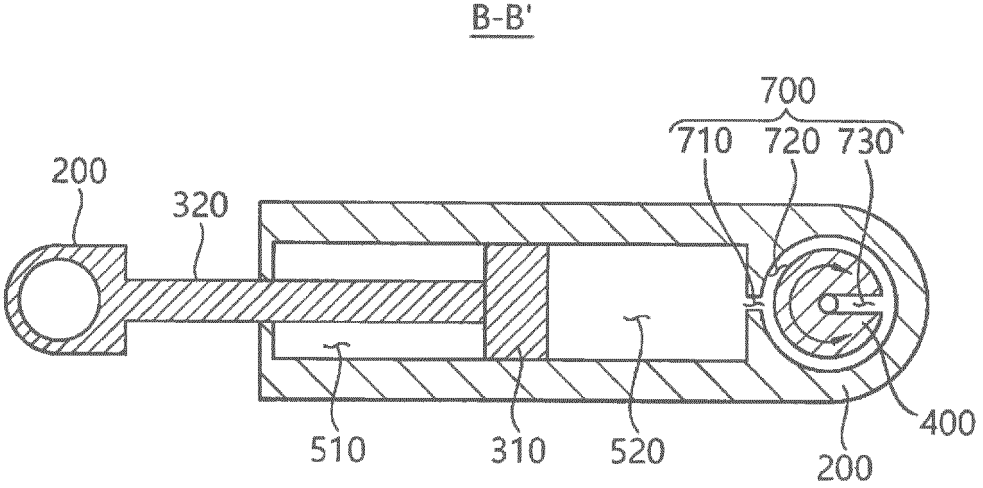
【Fig. 2】



【Fig. 3】

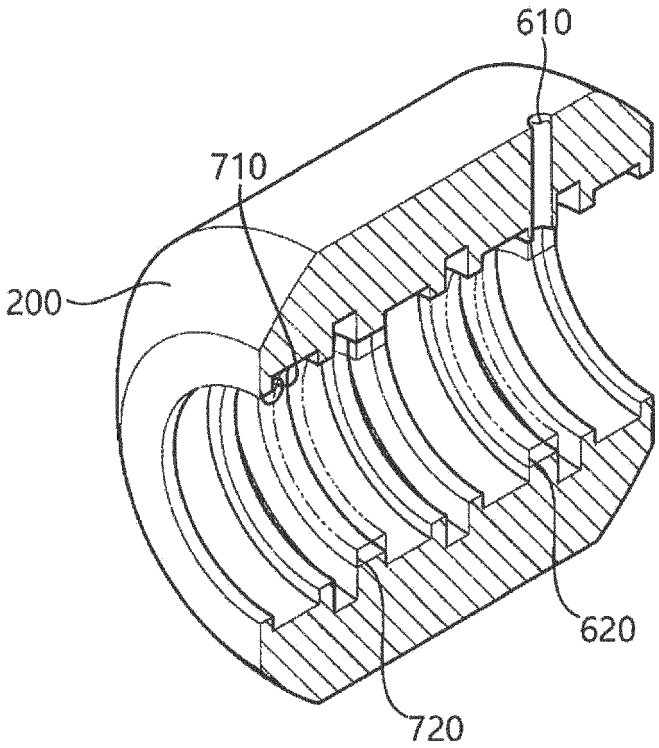

A-A'
600
610
620
630
200
320
510
310
520
200
400

(a)

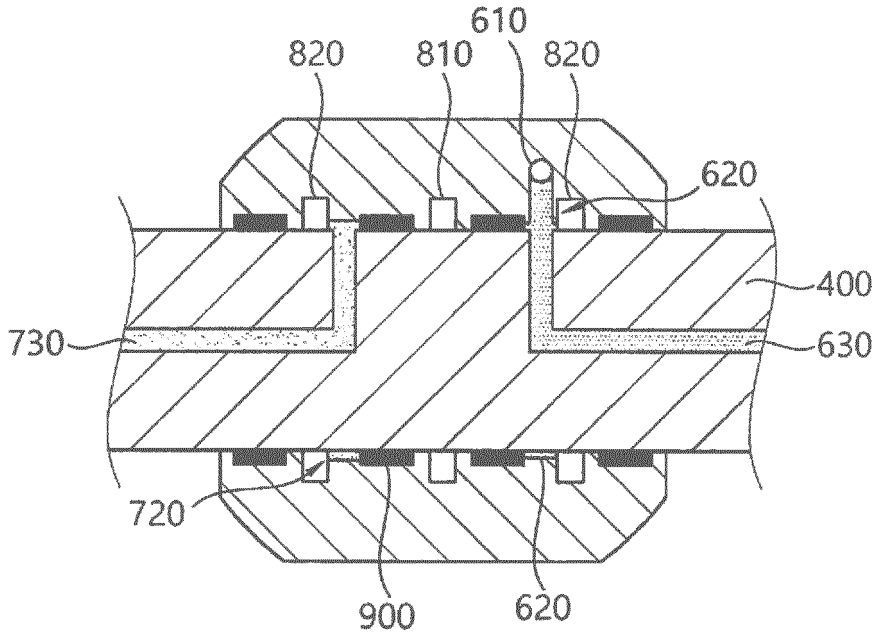

B-B'
700
710
720
730
200
320
510
310
520
200
400

(b)

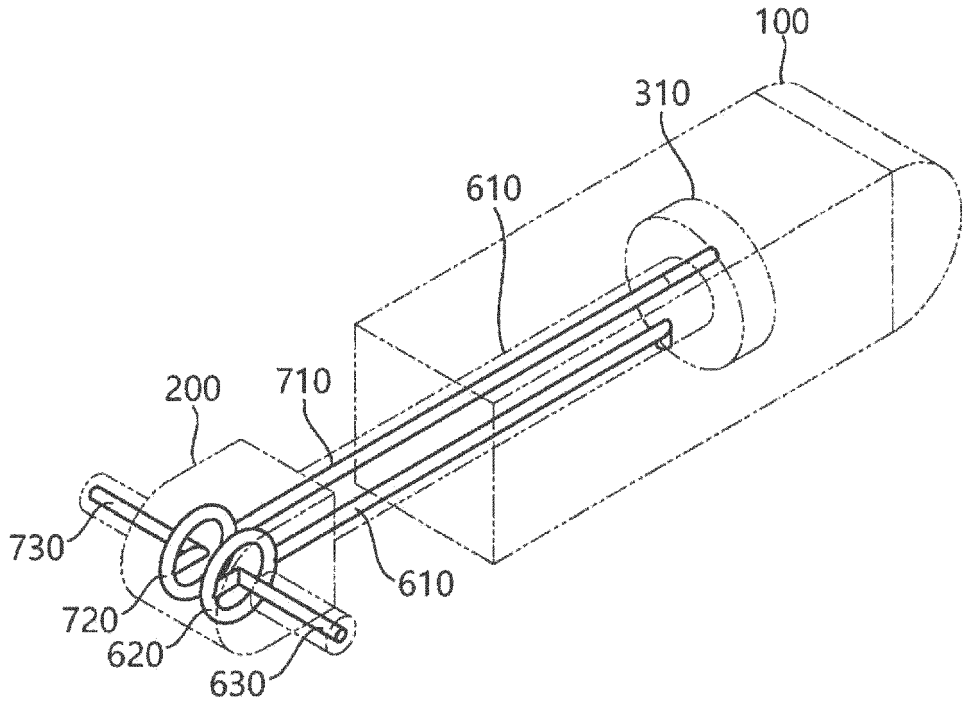
【Fig. 4】



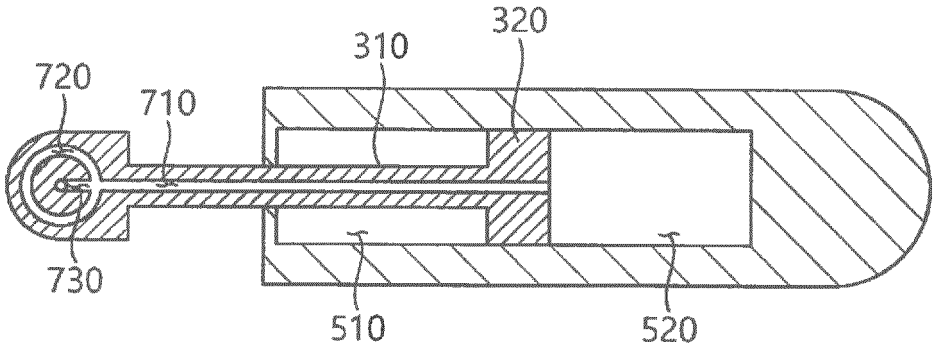
【Fig. 5】



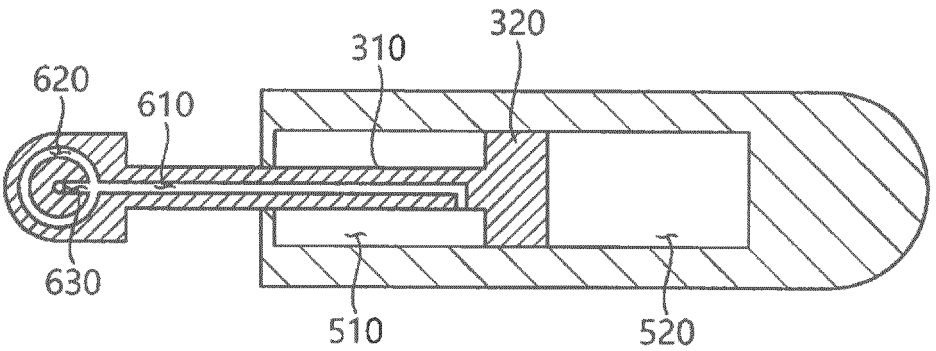
【Fig. 6】



【Fig. 7】

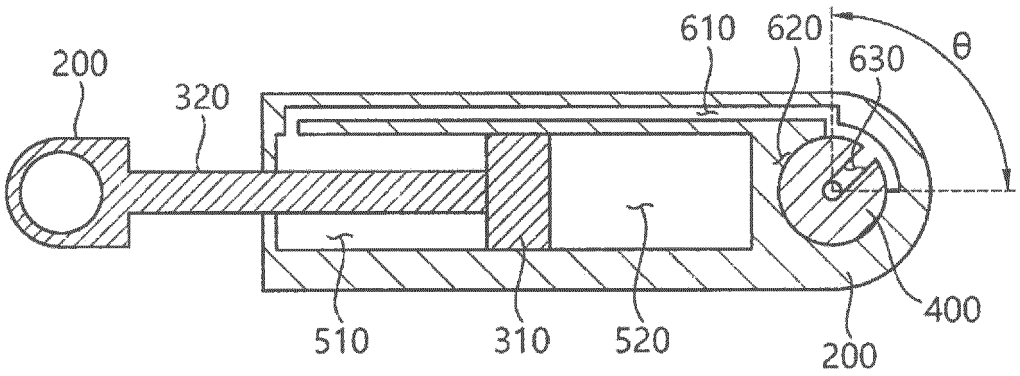


(a)



(b)

【Fig. 8】



INTERNATIONAL SEARCH REPORT

International application No.
PCT/KR2017/004051

A. CLASSIFICATION OF SUBJECT MATTER

F15B 15/08(2006.01)i, F15B 15/14(2006.01)i

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)

F15B 15/08; F15B 15/14; F15B 15/22; F15B 15/26; F15B 15/02; F16H 1/36; E02F 3/627

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
Korean Utility models and applications for Utility models: IPC as above
Japanese Utility models and applications for Utility models: IPC as above

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

eKOMPASS (KIPO internal) & Keywords: actuator, flow path, housing, piston, piston rod and hinge

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	JP 07-208409 A (MITSUBISHI HEAVY IND., LTD.) 11 August 1995 See paragraphs [0014]-[0033] and figures 1-3.	11,12
A		1-10,13-15
Y	KR 10-2000-0001835 A (VOLVO CONSTRUCTION EQUIPMENT AB.) 15 January 2000 See page 2 and figure 1.	11,12
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A	JP 2012-141058 A (GENERAL ELECTRIC COMPANY) 26 July 2012 See paragraphs [0010]-[0034] and figures 1-8.	1-15
A	JP 2001-504922 A (POS-LINE AB.) 10 April 2001 See claim 1 and figure 1.	1-15

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

* Special categories of cited documents:
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"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed
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"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
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"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
28 JUNE 2017 (28.06.2017)	**29 JUNE 2017 (29.06.2017)**

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INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/KR2017/004051

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