(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) **EP 1 867 880 A1**

(12) **EUROPEAN PATENT APPLICATION**

(43) Date of publication:
19.12.2007 Bulletin 2007/51

(51) Int Cl.:
F15B 15/28 *(2006.01)*

(21) Application number: **07008233.4**

(22) Date of filing: **23.04.2007**

(84) Designated Contracting States:
AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HU IE IS IT LI LT LU LV MC MT NL PL PT RO SE SI SK TR
Designated Extension States:
AL BA HR MK YU

(30) Priority: **16.06.2006 JP 2006166835**

(71) Applicant: **KAYABA INDUSTRY CO., LTD.**
Minato-ku,
Tokyo 105-6190 (JP)

(72) Inventor: **Ito, Tatsuo**
Tokyo 105-6190 (JP)

(74) Representative: **Grünecker, Kinkeldey,**
Stockmair & Schwanhäusser
Anwaltssozietät
Maximilianstrasse 58
80538 München (DE)

(54) **Fluid pressure cylinder unit with stroke sensor**

(57) A stroke sensor (100) detects a relative position of a piston (2a) with respect to a cylinder (1) of a fluid pressure cylinder (100). The stroke sensor (100) comprises a magnet (4) fixed to the piston (2a) and a sensor probe (3) fixed to the cylinder (1). The sensor probe (3) generates a signal in response to a relative position with respect to the magnet (4). The magnet (4) is gripped between a holder (6) which is fixed to the piston (2c) and a seat member (5) which is supported by the piston (2a). By gripping an elastically deformable shock absorbing member (7) between the magnet (4) and the holder (6), the precision with which the magnet (4) is positioned with respect to the piston (2) is increased while protecting the magnet (4) from damage due to excessive gripping force.

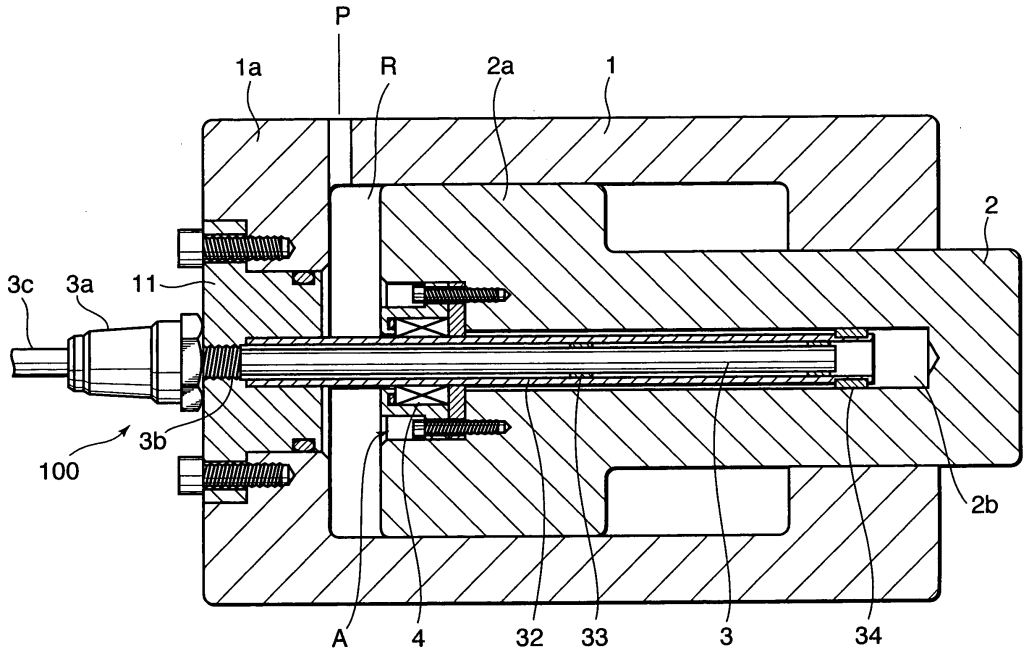

FIG. 1

EP 1 867 880 A1

Description

FIELD OF THE INVENTION

[0001] This invention relates to the installation of a stroke sensor in a fluid pressure cylinder.

BACKGROUND OF THE INVENTION

[0002] JPH11-190308A, published by the Japan Patent Office in 1999 proposes a stroke sensor for detecting a stroke position of a fluid pressure cylinder.

[0003] This stroke sensor comprises a sensor probe, a base of which is fixed to the cylinder and a tip of which is inserted into a bore formed axially in a piston rod through an opening formed in the central part of a piston.

[0004] A magnetostrictive wire is built into the sensor probe in an axial direction. By applying a pulsed electric current to the magnetostrictive wire, a magnetic field is formed on the outer circumference of the sensor probe in a circumferential direction. By disposing a magnet so as to face the outer circumference of the sensor probe in this state, the magnetic field in the circumferential direction and a magnetic field formed by the magnet in the axial direction are integrated, and as a result a torsional strain in the magnetic field is generated in the position of the magnet. This phenomenon is known as the Wiedemann effect.

[0005] The torsional strain in the magnetic field is transmitted as an acoustic wave along the magnetostrictive wire. The propagation period of this acoustic wave along the magnetostrictive wire has a linear relation with the distance from the magnet. By measuring the propagation period of this acoustic wave in a predetermined position of the magnetostrictive wire, the relative positions of the magnet and the sensor probe can be detected.

SUMMARY OF THE INVENTION

[0006] According to the prior art, the magnet is disposed in a recess formed in the central position of the piston. The opening of the recess faces the bottom of the cylinder. The magnet is gripped between a cap-shaped holder and a bottom of the recess. The holder is secured to the bottom of the recess by mounting screws.

[0007] Depending on the tightening force generated by the mounting screws, the axial position of the magnet may vary slightly. This variation causes a detection error in the stroke position. Further, if excessive torque is applied to the screws to secure the magnet firmly, the magnet may be damaged due to excessive tightening force.

[0008] It is therefore an object of this invention to improve the precision with which the magnet is positioned with respect to the piston as well as to protect the magnet from an excessive tightening force.

[0009] In order to achieve the above object, this invention provides a fluid pressure cylinder unit comprising, a cylinder, a piston housed in the cylinder so as to be free to slide in an axial direction, and a stroke sensor for detecting a relative position of the piston with respect to a cylinder.

[0010] The stroke sensor comprises a magnet fixed to one of the cylinder and the piston, and a sensor probe fixed to the other of the cylinder and the piston. The sensor probe generates a signal in response to a relative position in the axial direction with respect to the magnet.

[0011] The fluid pressure cylinder unit further comprises a shock absorbing member gripped between the magnet and the one of the cylinder and the piston. The shock absorbing member elastically deforms in the axial direction depending on a tightening force acting between the magnet and the one of the cylinder and the piston.

[0012] The details as well as other features and advantages of this invention are set forth in the remainder of the specification and are shown in the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

[0013] FIG. 1 is a longitudinal sectional view of a hydraulic pressure cylinder unit according to this invention.

[0014] FIG. 2 is an enlarged longitudinal sectional view of a magnet holding part of the hydraulic pressure cylinder unit.

[0015] FIG. 3 is an enlarged longitudinal sectional view of a magnet holding part according to another embodiment of this invention.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0016] Referring to FIG. 1 of the drawings, a hydraulic pressure cylinder unit comprises a cylinder 1, a piston 2a enclosed in the cylinder 1 so as to be free to slide, and a piston rod 2 connected to the piston 2a and projecting from the cylinder 1 in an axial direction.

[0017] A hydraulic pressure chamber R is delimited in the cylinder 1 by the piston 2a. The hydraulic pressure chamber R drives the piston 2a in the axial direction within the cylinder 1 according to hydraulic pressure supplied from a hydraulic pressure source P disposed on the outside of the cylinder 1.

[0018] Specifically, when hydraulic pressure is supplied to the hydraulic pressure chamber R from the hydraulic pressure source P, the hydraulic pressure chamber R expands, and the piston 2a displaces towards the right hand side of the figure. Accordingly, the piston rod 2 projects from the cylinder 1. This action is known as elongation of the hydraulic pressure cylinder unit.

[0019] On the other hand, when the hydraulic pressure is released from the hydraulic pressure chamber R to the hydraulic pressure source P, the hydraulic pressure chamber R contracts and the piston 2a displaces towards the left hand side of the figure in the cylinder 1. Accordingly, the piston rod 2 invades the cylinder 1. This action is known as contraction of the hydraulic pressure cylinder

unit.

[0020] To detect a relative position of the piston rod 2 with respect to the cylinder 1 in the axial direction, or in other words a stroke position of the piston 2, the hydraulic pressure cylinder unit comprises a stroke sensor 100.

[0021] The stroke sensor 100 comprises a sensor probe 3 fixed to the cylinder 1, and a magnet 4 fixed to the piston 2a.

[0022] The sensor probe 3 is formed from a non-magnetic material. The sensor probe 3 penetrates a hole formed in a bottom cap member 11 which is fixed to a bottom 1a of the cylinder 1. A base portion 3b of the sensor probe 3 is screwed into the bottom cap member 11. The sensor probe 3 projects into the cylinder 1 and is covered by a sheath 32. The sheath 32 is made of a non-magnetic material and an end thereof is fitted into the hole in the bottom cap member 11. The sensor probe 3 penetrates a ring-shaped centering guide 33 which is fitted in the sheath 32, and is maintained in a state of concentricity with the sheath 32 thereby.

[0023] A cylindrical recess A is formed in the central portion of the piston 2 facing the bottom 1a of the cylinder 1. A bore 2b connected to the recess A is formed in the piston rod 2 in the axial direction. The sensor probe 3 and the sheath 32 pass through the recess A and are inserted into the bore 2b. A centering guide 34 is fitted to the outer circumference of a tip of the sheath 32. The centering guide 34 is in contact with the inner circumference of the bore 2b so as to maintain the sheath 32 in a state of concentricity with the bore 2b.

[0024] A magnetostrictive wire extending in the axial direction is enclosed in the sensor probe 3. A probe head 3a is fitted to the base of the sensor probe 3 so as to be exposed to the outside of the bottom cap member 11. A cable 3c is connected to the magnetostrictive wire via the probe head 3a so as to supply the magnetostrictive wire with a pulsed electric current.

[0025] Referring to FIG. 2, the magnet 4 is enclosed in the recess A. The magnet 4 is formed into a cylindrical shape that is long in the axial direction. It is also possible to construct the magnet 4 in a ring-shape or to construct the magnet 4 by accumulating ring-shaped magnet elements in the axial direction.

[0026] The magnet 4 is enclosed in a cap-shaped holder 6 fixed to a bottom 2c of the recess A. The holder 6 is made of a non-magnetic material and provided with a through-hole through which the sheath 32 passes. The magnet 4 is arranged to face the outer circumference of the sheath 32 in the holder 6.

[0027] An annular groove is formed on a bottom 62b of the holder 6, and a shock absorbing member 7 is fitted therein.

[0028] A seat member 5 made of a non-magnetic material and having the same diameter as that of the recess A is fitted into the recess A so as to be in contact with the bottom 2c of the recess A. A flange 62a is formed at an opening of the holder 6. The diameter of the flange 62a is set in advance such that the outer circumference of the flange 62a comes into contact with the inner circumference 2d of the recess A. In the recess A, the holder 6 with the magnet 4 enclosed therein is fixed to the piston 2 by mounting screws 61 which penetrate bolt holes 5a formed in the flange 62a and the seat member 5 and are screwed into the piston 2.

[0029] In this fixed state, the magnet 4 is gripped between the shock absorbing member 7 and the seat member 5. The shock absorbing member 7 is constituted by an O-ring made of a rubber material or a synthetic resin. The dimension of the shock absorbing member 7 are set such that the shock absorbing member 7 projects from the annular groove in the bottom 62b of the holder 6 towards the seat member 5. By tightening the mounting screws 61 onto the piston 2, the magnet 4 is pressed against the shock absorbing member 7 and deforms the shock absorbing member 7. The magnet 4 is ultimately supported by the bottom 62b via the deformed shock absorbing member 7.

[0030] If the holder 6 is temporarily fixed to the seat member 5 by, for example, an adhesive in advance, fitting the magnet 4 and the holder 6 into the recess A can be performed easily.

[0031] The operation principle of the stroke sensor 100 is identical to that of the prior art.

[0032] According to this invention, the magnet 4 is gripped between the seat member 5 and the shock absorbing member 7 supported by the bottom 62b of the holder 6. Deformation of the shock absorbing member 7 prevents excessive compression force from acting on the magnet 4 even when the tightening force of the mounting screws 61 is excessive, thereby protecting the magnet 4 from damage due to the excessive tightening force. On the other hand, the shock absorbing member 7 exerts a resilient force on the magnet 4 so as to keep the magnet 4 in contact with the seat member 5 even when the tightening force of the mounting screws 6 is insufficient. According to this invention, therefore, the magnet 4 is maintained in the predetermined position with high precision irrespective of the tightening force of the mounting screws 61.

[0033] Next, referring to FIG. 3, another embodiment of this invention will be described.

[0034] In this embodiment, the entire holder 6 is formed into a cylindrical shape. A male screw 62c is formed on the outer circumference of the holder 62 and a female screw is formed on the inner circumference 2d of the recess A. By screwing the male screw 62c into the female screw on the inner circumference 2d of the recess A, or in other words by screwing the holder 6 directly into the recess A, the holder 6 is fixed to the piston 2a. The magnet 4 is gripped between the seat member 5 and the bottom 62b via the shock absorbing member 7 as in the case of the first embodiment under the tightening force of the holder 6 screwed into the recess A.

[0035] According to this embodiment also, deformation of the shock absorbing member 7 protects the magnet 4 from damage due to excessive tightening force

while ensuring precise positioning of the magnet 4. Further, the mounting screws 61 are omitted in this embodiment, and hence the number of components required for installing the stroke sensor 100 can be decreased.

[0036] The contents of Tokugan 2006-166835, with a filing date of June 16, 2006 in Japan, are hereby incorporated by reference.

[0037] Although the invention has been described above with reference to certain embodiments of the invention, the invention is not limited to the embodiments described above. Modifications and variations of the embodiments described above will occur to those skilled in the art, within the scope of the claims.

[0038] For example, in the embodiments described above, the sensor probe 3 is fixed to the cylinder 1 while the magnet 4 is fixed to the piston 2a, but this invention can be applied to a fluid pressure sensor in which the magnet is fixed to the cylinder while the sensor probe is 'fixed to the piston.

[0039] In the embodiments described above, the shock absorbing member 7 is disposed in the annular groove formed on the bottom 62b of the holder 6, but the annular groove for accommodating the shock absorbing member 7 may be formed in the seat member 5.

[0040] In the embodiments described above, the hydraulic pressure cylinder is a single rod type, but this invention can be applied to a double rod type hydraulic pressure cylinder. This invention can be applied to any kind of hydraulic pressure cylinder including cylinder for seismic isolation of civil or architectural structures. Further, the fluid pressure cylinder to which this invention is applied should not be limited to a hydraulic pressure cylinder. This invention can be also applied to an air pressure cylinder, for example.

[0041] The embodiments of this invention in which an exclusive property or privilege is claimed are defined as follows:

Claims

1. A fluid pressure cylinder unit comprising:

a cylinder (1);
a piston (2a) housed in the cylinder (1) so as to be free to slide in an axial direction;
a stroke sensor (100) for detecting a relative position of the piston (2a) with respect to a cylinder (1), the stroke sensor (100) comprising a magnet (4) fixed to one of the cylinder (1) and the piston (2a), and a sensor probe (3) fixed to the other of the cylinder (1) and the piston (2a), the sensor probe (3) generating a signal in response to a relative position in the axial direction with respect to the magnet (4); and
a shock absorbing member (7) gripped between the magnet (4) and the one of the cylinder (1) and the piston (2a), the shock absorbing member (7) elastically deforming in the axial direction depending on a tightening force acting between the magnet (4) and the one of the cylinder (1) and the piston (2a).

2. The fluid pressure cylinder unit as defined in Claim 1, wherein the sensor probe (3) is fixed to the cylinder (1) and the magnet (4) is fixed to the piston (2a).

3. The fluid pressure cylinder unit as defined in Claim 2, wherein the piston (2a) has a recess (A) in a central portion, the magnet (4) is formed into a cylindrical shape facing an outer circumference of the sensor probe (3) and accommodated in a holder (6) which is disposed in a recess (A) and fixed to the piston (2a), and the shock absorbing member (7) is interposed between the holder (6) and the magnet (4).

4. The fluid pressure cylinder unit as defined in Claim 3, wherein the holder (6) is formed into a cap-shape having a bottom (62b), the shock absorbing member (7) is accommodated in an annular groove formed in the bottom (62b) of the holder (6), and the magnet (4) is gripped between the piston (2a) and the bottom (62b) of the holder (6) via the shock absorbing member (7).

5. The fluid pressure cylinder unit as defined in Claim 4, wherein the shock absorbing member (7) is constituted by an annular member formed from a rubber or a synthetic resin.

6. The fluid pressure cylinder unit as defined in Claim 5, wherein a dimension of the shock absorbing member (7) is set such that the shock absorbing member (7) projects from the annular groove in the axial direction and elastically deforms when pressed by the magnet (4).

7. The fluid pressure cylinder unit as defined in any one of Claim 4 through Claim 6, wherein the holder (6) comprises a flange (62a) which comes into contact with an inner circumference (2d) of the recess (A), and is fixed to the piston (2a) by a mounting screw (61) which penetrates the flange (62a).

8. The fluid pressure cylinder unit as defined in any one of Claim 4 through Claim 6, wherein the holder (6) is screwed directly into an inner circumference (2d) of the recess (A).

9. The fluid pressure cylinder unit as defined in Claim 7 or Claim 8, further comprising a seat member (5) gripped between the holder (6) and the piston (2a), wherein the seat member (5) has an outer circumference which comes into contact with the inner circumference (2d) of the recess (A), and an axial end of the magnet (4) is supported by the piston (2a) via

the seat member (5) and another axial end of the magnet (4) is supported by the bottom (62b) of the holder (6) via the shock absorbing member (7).

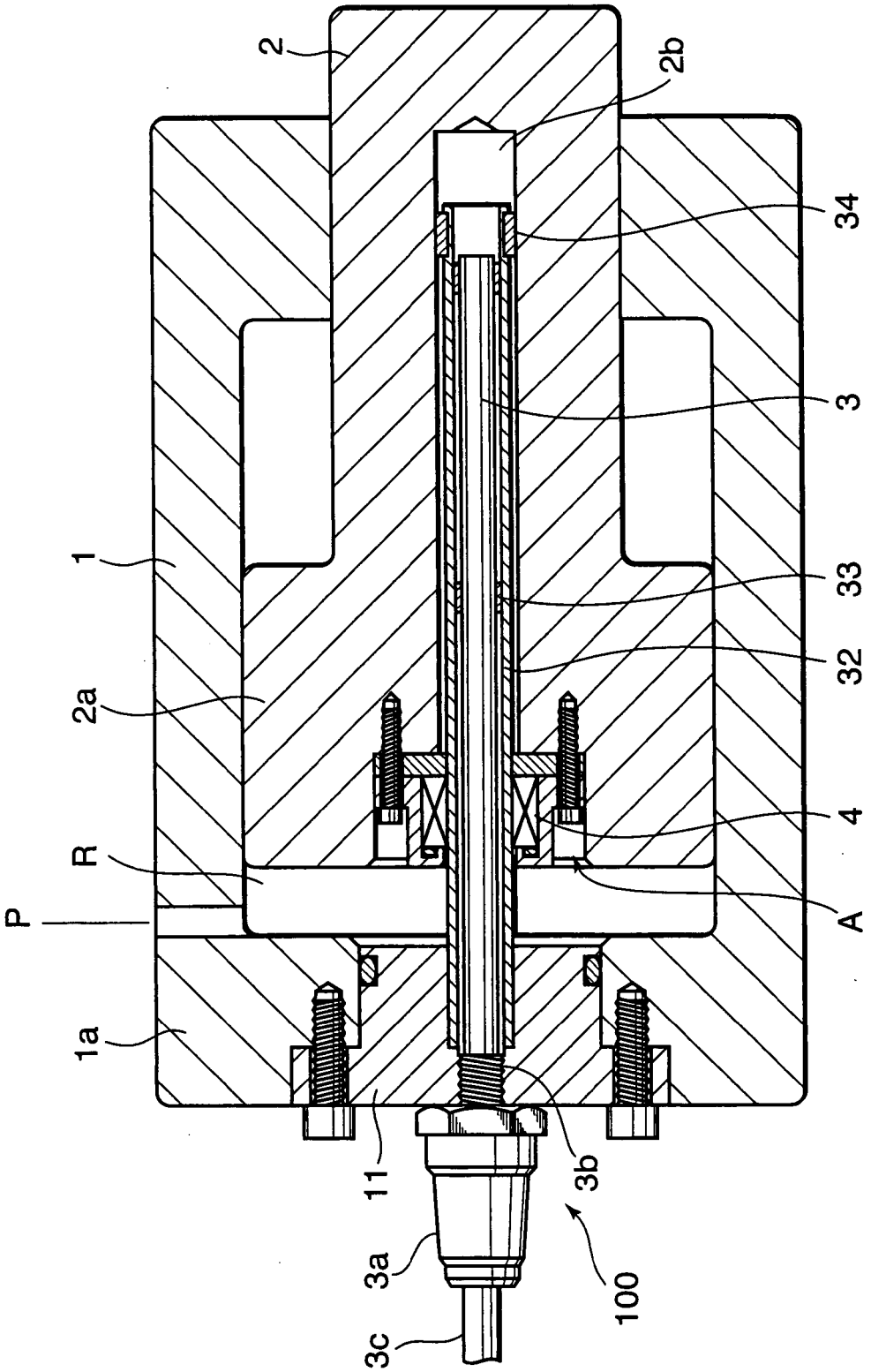

FIG. 1

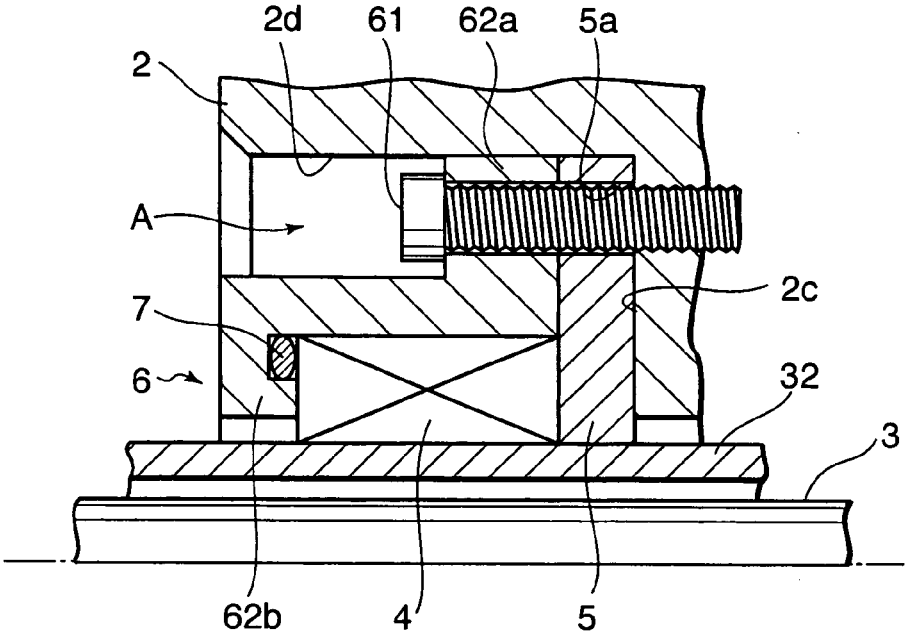

FIG. 2

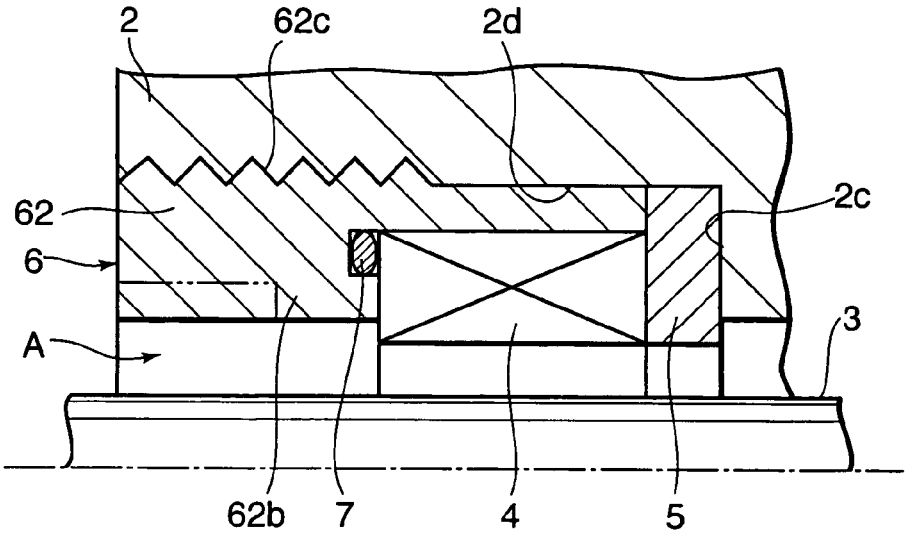

FIG. 3

European Patent Office

EUROPEAN SEARCH REPORT

Application Number
EP 07 00 8233

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X	EP 1 217 220 A2 (CATERPILLAR INC [US]) 26 June 2002 (2002-06-26) * paragraph [0020]; figure 6 *	1-5,8	INV. F15B15/28
X	AT 392 126 B (WEBER OELHYDRAULIK [AT]) 25 January 1991 (1991-01-25) * page 2, line 57 - page 3, line 28 *	1-5	
X	US 5 150 049 A (SCHUETZ JOHN L [US]) 22 September 1992 (1992-09-22) * column 3, line 62 - column 4, line 48 *	1,2	
X	DE 296 07 993 U1 (FESTO KG [DE]) 1 August 1996 (1996-08-01) * page 12, paragraph 2 - page 14, paragraph 1 *	1,2	
A,D	JP 11 190308 A (KAYABA INDUSTRY CO LTD) 13 July 1999 (1999-07-13) * abstract *	1	

TECHNICAL FIELDS SEARCHED (IPC)

F15B

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	11 September 2007	Toffolo, Olivier

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
Y : particularly relevant if combined with another document of the same category
A : technological background
O : non-written disclosure
P : intermediate document

T : theory or principle underlying the invention
E : earlier patent document, but published on, or after the filing date
D : document cited in the application
L : document cited for other reasons

& : member of the same patent family, corresponding document

EPO FORM 1503 03.82 (P04C01)

ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 07 00 8233

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report. The members are as contained in the European Patent Office EDP file on
The European Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

11-09-2007

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
EP 1217220 A2	26-06-2002	US 2002074994 A1	20-06-2002
AT 392126 B	25-01-1991	AT 4889 A	15-07-1990
US 5150049 A	22-09-1992	NONE	
DE 29607993 U1	01-08-1996	DE 19715858 A1	13-11-1997
		IT MI971000 A1	30-10-1998
		US 5813313 A	29-09-1998
JP 11190308 A	13-07-1999	NONE	

EPO FORM P0459

For more details about this annex : see Official Journal of the European Patent Office, No. 12/82

REFERENCES CITED IN THE DESCRIPTION

This list of references cited by the applicant is for the reader's convenience only. It does not form part of the European patent document. Even though great care has been taken in compiling the references, errors or omissions cannot be excluded and the EPO disclaims all liability in this regard.

Patent documents cited in the description

- JP H11190308 A **[0002]**
- JP 2006166835 A **[0036]**