

(19)



(11)

EP 2 796 727 A1

(12)

EUROPEAN PATENT APPLICATION

(43) Date of publication:
29.10.2014 Bulletin 2014/44

(51) Int Cl.:
F15B 11/06 ^(2006.01) **F15B 21/00** ^(2006.01)
F16K 1/44 ^(2006.01)

(21) Application number: **14164009.4**

(22) Date of filing: **09.04.2014**

(84) Designated Contracting States:
**AL AT BE BG CH CY CZ DE DK EE ES FI FR GB
GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO
PL PT RO RS SE SI SK SM TR**
Designated Extension States:
BA ME

(71) Applicant: **Koganei Corporation**
Koganei-shi
Tokyo 184-8533 (JP)

(72) Inventor: **Horikawa, Akiyoshi**
Tokyo, 184-8533 (JP)

(30) Priority: **22.04.2013 JP 2013089616**

(74) Representative: **Manitz, Finsterwald & Partner**
GbR
Martin-Greif-Strasse 1
80336 München (DE)

(54) **Dew condensation preventing valve**

(57) It is an object of the present invention to provide a dew condensation preventing valve for preventing occurrence of dew condensation in a pneumatic actuator while effectively using air in the pipe. A dew condensation preventing valve 30a is applicable to a pneumatic system 10 having a pneumatic actuator having a pressure chamber to which compressed air is supplied. A valve housing 31 has an air intake port 33 and an air discharge port 34, which open into pressure chambers 17a and 17b, an on-off valve assembly 36 is reciprocable between a forward

limit cutoff position and a backward limit cutoff position, and configured to prevent the air intake port 33 and the air discharge port 34 from communicating with each other at the forward limit cutoff position and the backward limit cutoff position. When the on-off valve assembly 36 is being moved between the forward limit cutoff position and the backward limit cutoff position, the air intake port 33 and the air discharge port 34 communicates with each other, and air in the pressure chambers 17a and 17b is partially discharged to the outside.

EP 2 796 727 A1

Description

CROSS-REFERENCE TO RELATED APPLICATION

[0001] The present application claims priority from Japanese Patent Application No. 2013-089616 filed on April 22, 2013, the content of which is hereby incorporated by reference into this application.

TECHNICAL FIELD OF THE INVENTION

[0002] The present invention relates to a dew condensation preventing valve for preventing dew condensation in a pneumatic system having a pneumatic actuator which is driven by compressed air.

BACKGROUND OF THE INVENTION

[0003] As a pneumatic actuator for driving a reciprocating member by employing compressed air as driving medium, a pneumatic cylinder for linearly reciprocating a piston rod, a swinging actuator for swinging a rotating member, and the like have been known. The swinging actuator is also referred to as "rotary actuator". The pneumatic cylinder has a casing in which a piston is housed and linearly reciprocable, and the piston is provided with a piston rod protruding from the casing. In a pneumatic cylinder called as a double-acting type, pressure chambers are provided on respective sides of the piston, and configured to apply thrust forces to the piston by compressed air in two directions including: a forward direction in which the piston rod protrudes from the casing; and a backward direction in which the piston rod is retracted into the casing. In a pneumatic cylinder called as a single-acting type, when driving the piston in one of the forward and backward directions, a thrust force is applied to the piston by compressed air, and when driving the piston in the other of the forward direction and the backward direction, a thrust force is applied to the piston by a spring member.

[0004] The pressure chambers provided in the pneumatic actuator such as pneumatic cylinder are connected to a compressed air supply such as compressor, which is away from the actuator, via a piping such as tubes. In order to switch between a state in which compressed air is supplied to the pressure chamber and a state in which air in the pressure chamber is discharged to the outside, the piping are provided with a fluid channel switching valve for switching fluid channels. In a case in which: the sectional area of a reciprocating member such as a piston provided in the pneumatic actuator is small; the reciprocating stroke thereof is short; and the piping between the fluid channel switching valve and the pneumatic actuator is long, the inner volume of the piping is larger than that of the pressure chamber. In this case, low-pressure air discharged from the pressure chamber remains in the pipe without being discharged to the outside, is pressurized when compressed air is supplied again, and is re-

turned to the pressure chamber again. When the air remaining in the pressure chamber and the piping repeats the pressurized state and the depressurized state in this manner, the air undergoes adiabatic expansion, and water vapor contained in the air becomes dew condensation water and remains in the pressure chamber and the piping in some cases.

[0005] Dew condensation preventing circuits configured to prevent occurrence of dew condensation in pressure chambers and piping without increasing the dryness of compressed air are described in Patent Documents 1 to 3. The dew condensation preventing circuit described in Patent Document 1 has a check valve which is provided at a piping connected to a supply and discharge port of a pneumatic actuator, and configured to discharge all of the air in the pressure chamber to the outside from the check valve when the pressure of the pressure chamber is depressurized. Each of the dew condensation preventing circuits described in Patent Documents 2 and 3 has: a piping through which an output port of a fluid channel switching valve and a supply and discharge port of a pneumatic cylinder communicate with each other; and a bypass pipe disposed in parallel with this piping, compressed air is supplied from the output port to the supply and discharge port of the pneumatic cylinder via the piping, and when compressed air is discharged from the supply and discharge port, air to be discharged is returned to the fluid channel switching valve via the bypass pipe.

PRIOR ART DOCUMENTS

PATENT DOCUMENTS

[0006]

Patent Document 1: Japanese Utility Model Application Laid-Open Publication No. H04-116004,
Patent Document 2: Japanese Utility Model Application Laid-Open Publication No. S54-165686, and
Patent Document 3: Japanese Patent Application Laid-Open Publication No. H10-009205

[0007] However, in order to prevent occurrence of dew condensation in the pressure chamber and the like, if only compressed air from the compressed air supply is supplied to the pressure chamber when all of the compressed air in the pressure chamber is discharged to the outside to drive the reciprocating member, the volume of the compressed air supplied to the pressure chamber for driving the pneumatic actuator is increased. Particularly, in an assembly factory for manufacturing mass-produced products such as electronic components, many pneumatic actuators are being used. Therefore, if all of compressed air in the pressure chambers is discharged to supply only new compressed air to the pressure chamber, the used volume of compressed air is increased; therefore, power consumption of a compressor for gen-

erating compressed air is wastefully increased.

[0008] It is an object of the present invention to prevent dew condensation in a pneumatic system while making effective use of air in a piping.

SUMMARY OF THE INVENTION

[0009] In accordance with one aspect of the present invention, a dew condensation preventing valve for preventing occurrence of dew condensation in a pneumatic system provided with: a pneumatic actuator having a pressure chamber to which compressed air is supplied; and a pipe through which compressed air is supplied from a compressed air supply to the pressure chamber, comprises: a valve housing provided with a valve element housing hole which opens into an air intake port communicating with the pressure chamber, and opens into an air discharge port communicating with outside; an on-off valve assembly provided to the valve housing, reciprocable between a forward limit cutoff position and a backward limit cutoff position, and configured to prevent the air intake port and the air discharge port from communicating with each other at the forward limit cutoff position and the backward limit cutoff position; a spring member for applying a spring force to the on-off valve assembly toward the forward limit cutoff position; and a communication section provided to the valve housing, and configured to cause the air intake port and the air discharge port to communicate with each other when the on-off valve assembly is positioned between the forward limit cutoff position and the backward limit cutoff position.

EFFECTS OF THE INVENTION

[0010] The dew condensation preventing valve has a valve housing provided with: an air intake port which communicates with the pressure chamber of the pneumatic actuator; and an air discharge port which communicates with the outside, and the on-off valve assembly provided in the valve housing is moved between the forward limit cutoff position and the backward limit cutoff position at which communication between the air intake port and the air discharge port is interrupted. In that moving process, the air intake port and the air discharge port takes a communication state to communicate with each other via the communication section, and part of the compressed air supplied to the pressure chamber is momentarily discharged to the outside. When air is discharged from the pressure chamber to return the air intake port from a pressurized state to an atmospheric pressure, the on-off valve assembly is moved from the backward limit open position to the forward limit open position. In that moving process, the air intake port and the air discharge port become a communicated state via the communication section, and part of the air therein is momentarily discharged to the outside. Therefore, even when low-pressure air discharged from the pressure chamber remains in the pressure chamber and piping, at every operation of supplying

to and discharging compressed air from the pressure chamber, part of the air in the pressure chamber and the piping is discharged to the outside, and new air corresponding to the discharged volume is supplied from the compressed air supply. In this manner, part of the remaining air is ventilated; therefore, the dryness of the air in the pressure chamber and piping can be maintained. As a result, even when air remaining in the pressure chamber and piping repeats a pressurized state and a depressurized state, dew condensation can be prevented from occurring in the pressure chamber and piping.

[0011] Furthermore, the remaining air in the pressure chamber and piping is momentarily discharged to the outside by the high-pressure compressed air supplied to the pressure chamber; therefore, the air in the piping can be effectively utilized by increasing the air volume remained in the pressure chamber and piping through the all discharge stroke in which low-pressure air is discharged from the pressure chamber of the pneumatic actuator, different from the case of the conventional technique that discharges air in the pressure chamber to the outside. As a result, the air supply volume from the compressed air supply in the pneumatic system can be suppressed, and occurrence of dew condensation can be reliably prevented.

BRIEF DESCRIPTION OF THE DRAWINGS

[0012]

FIG. 1 is a sectional view showing one embodiment of a dew condensation preventing valve provided to a pneumatic actuator;

FIG. 2A is an enlarged sectional view showing the dew condensation preventing valve with an on-off valve assembly taking a forward limit cutoff position; FIG. 2B is a sectional view showing the dew condensation preventing valve with the on-off valve assembly taking a backward limit cutoff position;

FIG. 3A is an enlarged sectional view showing the dew condensation preventing valve with the on-off valve assembly being between the forward limit cutoff position and the backward limit cutoff position; FIG. 3B is a sectional view taken along a line 3B-3B in FIG. 3A;

FIG. 4 is a timing chart showing operating characteristics of the dew condensation preventing valve; FIG. 5 is a sectional view showing one variation of the dew condensation preventing valve provided to the pneumatic actuator;

FIG. 6 is an enlarged sectional view of the dew condensation preventing valve shown in FIG. 5;

FIG. 7 is a sectional view showing another variation of the dew condensation preventing valve;

FIG. 8A is a sectional view showing still another variation of the dew condensation preventing valve with the on-off valve assembly taking the backward limit cutoff position;

FIG. 8B is a sectional view showing the dew condensation preventing valve with the on-off valve assembly taking the forward limit cutoff position; and FIG. 8C is a sectional view showing the dew condensation preventing valve with the on-off valve assembly being between the forward limit cutoff position and the backward limit cutoff position.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0013] Hereinafter, embodiments of the present invention will be described in detail on the basis of the drawings. In each embodiment, duplicated explanation of common elements is omitted and those elements are denoted by the same reference characters.

[0014] A pneumatic system 10 shown in FIG. 1 has a pneumatic cylinder serving as a pneumatic actuator 11. This pneumatic actuator 11 has a casing 12 made of an approximately rectangular parallelepiped blockish material, and the casing 12 is provided with a piston housing hole 13. A piston 14 is housed in the piston housing hole 13 and linearly reciprocable, and a piston rod 15 attached to the piston 14 protrudes outside the casing 12 from an open end of the piston housing hole 13. A rod cover 16 is attached to an open end portion of the piston housing hole 13, and the piston rod 15 is slidably supported by a through hole of the rod cover 16.

[0015] The piston housing hole 13 is divided into a first pressure chamber 17a and a second pressure chamber 17b by the piston 14. The first pressure chamber 17a is formed by the piston 14 and the rod cover 16 as a returning-side pressure chamber for applying a thrust force to the piston 14 in a returning direction of the piston rod 15. The second pressure chamber 17b is formed by the piston 14 and the bottom surface of the piston housing hole 13 as a protruding-side pressure chamber for applying a thrust force to the piston 14 in a protruding direction of the piston rod 15. The pneumatic actuator 11 causes the piston rod 15 as a reciprocating member to linearly reciprocate in an axial direction by the compressed air supplied to the pressure chambers 17a and 17b.

[0016] The piston 14 is provided with a seal member 18a for sealing the pressure chambers 17a and 17b from each other. The rod cover 16 is provided with: a seal member 18b for sealing a gap between the rod cover 16 and the piston rod 15; and a seal member 18c for sealing a gap between the rod cover 16 and the piston housing hole 13.

[0017] The casing 12 is provided with: a supply and discharge port 21a which communicates with the pressure chamber 17a; and a supply and discharge port 21b which communicates with the pressure chamber 17b. The casing 12 is provided with pipe connecting sections 22a and 22b which communicate with the pressure chambers 17a and 17b via the supply and discharge ports 21a and 21b, respectively. A piping 23a composed of hoses or tubes is connected to the pipe connecting sec-

tion 22a by screw members (not shown), and a piping 23b is similarly connected to the pipe connecting section 22b. The piping 23a and 23b are connected to a compressed air supply 24, which is composed of a compressor and the like, via a fluid channel switching valve 25. The fluid channel switching valve 25 is movable between a first position, i.e., a position "A" at which compressed air is supplied to the pressure chamber 17a and air in the pressure chamber 17b is discharged and a second position, i.e., a position "B" at which compressed air is supplied to the pressure chamber 17b and air in the pressure chamber 17a is discharged. FIG. 1 shows a state in which the fluid channel switching valve 25 takes the position "A", and the piston rod 15 was driven in the returning direction by the compressed air supplied to the pressure chamber 17a. When compressed air is alternately supplied to the pressure chambers 17a and 17b, the piston rod 15 as the reciprocating member is reciprocated in the axial direction.

[0018] As described above, the pneumatic system 10 shown in FIG. 1 has: the pneumatic actuator 11 having the piston rod 15 to which the thrust force is applied by the compressed air supplied to the pressure chambers 17a and 17b; and piping 23a and 23b through which compressed air is supplied from the compressed air supply 24 to the pressure chambers 17a and 17b. In order to attach the pneumatic actuator 11 to a supporting member (not shown), screw holes 26 are provided to a front surface of the casing 12, and a front end portion of the casing 12 is provided with attachment holes 27. Additionally, a nut 28 for fastening a member to be driven by the piston rod 15 is attached to a protruding end portion of the piston rod 15.

[0019] Two dew condensation preventing valves 30a is attached to the casing 12 so as to correspond to the respective pressure chambers 17a and 17b. Since the dew condensation preventing valves 30a are the same as each other in structure, "(1)" is added to the reference character "30a" of the first dew condensation preventing valve, and "(2)" is added to the reference character "30a" of the second dew condensation preventing valve.

[0020] FIGS. 2A and 2B are an enlarged sectional views showing a dew condensation preventing valve 30a shown in FIG. 1. The dew condensation preventing valve 30a has a valve housing 31, this valve housing 31 has: a cylindrical section 31a; and a male screw section 31b integrally formed with its distal end portion, and a spring receiving member 31c is attached to a rear end portion of the cylindrical section 31a. The valve housing 31 is provided with a valve element housing hole 32, and both end portions of the valve element housing hole 32 open into an air intake port 33 which communicates with the pressure chamber and which is provided to the male screw section 31b, and open into an air discharge port 34 which communicates with the outside and which is provided to the spring receiving member 31c. As shown in FIG. 1, the casing 12 of the pneumatic actuator 11 is provided with communication holes 35a and 35b through

which the air intake ports 33 of the dew condensation preventing valves 30a communicate with the respective pressure chambers 17a and 17b. Two dew condensation preventing valves 30a are attached to the casing 12 by screw-coupling of the male screw sections 31b thereof to respective screw holes provided to the casing 12, and the air intake ports 33 communicate with the pressure chambers 17a and 17b via the communication holes 35a and 35b.

[0021] The valve housing 31 is provided with an on-off valve assembly 36 which is reciprocable in an axial direction. As shown in FIGS. 2A and 2B, this on-off valve assembly 36 has: a valve shaft 37; a first valve supporting section 38a provided to a rear end of the valve shaft 37; and a second valve supporting section 38b provided to a distal end of the valve shaft 37; and the two valve supporting sections 38a and 38b are distant from each other in the axial direction. The on-off valve assembly 36 is reciprocable between a forward limit cutoff position at which a distal end surface of the valve shaft 37 comes in contact with an abutting surface 39a provided to the valve housing 31 and a backward limit cutoff position at which a rear end surface of the valve shaft 37 comes in contact with an abutting surface 39b of the spring receiving member 31c. The air intake port 33 opens on the abutting surface 39a, and the air discharge port 34 opens on the abutting surface 39b.

[0022] FIG. 2A shows a state where the on-off valve assembly 36 takes a forward limit cutoff position, and FIG. 2B shows a state where the on-off valve assembly 36 takes a backward limit cutoff position. FIG. 3A is an enlarged sectional view showing the dew condensation preventing valve with the on-off valve assembly 36 being distant from and on the way to the forward limit cutoff position or the backward limit cutoff position, and FIG. 3B is a sectional view taken along a line 3B-3B in FIG. 3A.

[0023] In order to apply a spring force to the on-off valve assembly 36 toward the forward limit cutoff position, a compression coil spring 41 serving as a spring member is attached between the valve receiving member 31c and the on-off valve assembly 36. When compressed air of the pressure chambers 17a and 17b of the pneumatic actuator 11 is discharged toward the fluid channel switching valve 25, and the pressure of the air intake port 33 is reduced, the compression coil spring 41 causes the on-off valve assembly 36 to move toward the forward limit cutoff position. On the other hand, when compressed air is supplied from the fluid channel switching valve 25 to the pressure chambers 17a and 17b, and the pressure of the air intake port 33 is increased, the on-off valve assembly 36 is moved from the forward limit cutoff position to the backward limit cutoff position by the compressed air, and the compression coil spring 41 is compressed as shown in FIG. 2B.

[0024] In this specification, the air intake port 33 of the on-off valve assembly 36 is constituted as a distal end, the air discharge port 34 is constituted as a rear end, the movement of the on-off valve assembly 36 toward the air

intake port 33 is defined as "forward movement", and the movement toward the air discharge port 34 is defined as "backward movement". Therefore, a first cutoff position at which the on-off valve assembly 36 abuts the abutting surface 39a on the same side as the air intake port 33 is defined as "forward limit cutoff position", and a second cutoff position at which the on-off valve assembly 36 abuts the abutting surface 39b on the same side as the air discharge port 34 is defined as "backward limit cutoff position".

[0025] The valve housing 31 is provided with: a valve seat hole 42 extending in the axial direction; and a sleeve 43 provided in the valve seat hole 42 and movable in the axial direction. Guide sections 44a and 44b are respectively provided on the distal end side of the first valve supporting section 38a and on the rear end side of the second valve supporting section 38b, and the guide sections 44a and 44b are received in the sleeve 43. As shown in FIG. 3B, the sleeve 43 is formed with a slit extending in the axial direction, and this slit forms a communication section 45. The air intake port 33 and the air discharge port 34 communicate with each other via the communication section 45. Under the condition that the guide sections 44a and 44b are longer than those of the illustrated case, and the sleeve 43 is shorter than that of the illustrated case, the sleeve 43 cannot be moved according to the movement of the on-off valve assembly 36.

[0026] Valve seal members 46a and 46b in contact with the valve seat hole 42 are respectively attached to the first valve supporting section 38a and the second valve supporting section 38b. When the on-off valve assembly 36 is at the forward limit cutoff position as shown in FIG. 2A, the first valve seal member 46a is in contact with the valve seat hole 42, and the communication between the communication section 45 comprised of the slit and the air discharge port 34 is interrupted. At this point, the second valve seal member 46b is separated from the valve seat hole 42. On the other hand, when the on-off valve assembly 36 is at the backward limit cutoff position, as shown in FIG. 2B, the second valve seal member 46b is in contact with the valve seat hole 42, and the communication between the air intake port 33 and the communication section 45 is interrupted. At this point, the first valve seal member 46a is separated from the valve seat hole 42.

[0027] In this manner, in the cases in which the on-off valve assembly 36 is at the forward limit cutoff position and the backward limit cutoff position, at either position, the communication between the air intake port 33 and the air discharge port 34 is interrupted. The interval between the position at which the valve seal member 46a contacts the valve seat hole 42 when the on-off valve assembly 36 is at the forward limit cutoff position as shown in FIG. 2A and the position at which the valve seal member 46b contacts the valve seat hole 42 when the on-off valve assembly 36 is at the backward limit cutoff position as shown in FIG. 2B is L0. If the interval between the two valve seal members 46a and 46b is L1, L0 is

shorter than L1. Therefore, when compressed air is supplied to the air intake port 33 to move the on-off valve assembly 36 from the forward limit cutoff position toward the backward limit cutoff position against the spring force of the compression coil spring 41, a state in which both of the valve seal members 46a and 46b are not in contact with the valve seat hole 42 is generated during the movement. Since both of the valve seal members 46a and 46b are not in contact with the valve seat hole 42, the air intake port 33 and the air discharge port 34 are in the state communicated by the communication section 45. When the compressed air of the air intake port 33 is discharged to reduce the pressure therein and moves the on-off valve assembly 36 from the backward limit cutoff position toward the forward limit cutoff position, a state in which both of the valve seal members 46a and 46b are not in contact with the valve seat hole 42 is generated during the movement. Since both of the valve seal members 46a and 46b are not in contact with the valve seat hole 42, the air intake port 33 and the air discharge port 34 are in the state communicated by the communication section 45.

[0028] Therefore, when the piston rod 15 is moved to protrude by supplying compressed air to the pressure chamber 17b, discharging the air in the pressure chamber 17a to the outside, and applying a thrust force to the piston 14 by the compressed air supplied to the pressure chamber 17b, part of the compressed air supplied from the pipe 23b to the pressure chamber 17b is discharged to the outside from the air discharge port 34 of the dew condensation preventing valve 30a(2). In that process, part of the air in the pressure chamber 17a is discharged to the outside from the air discharge port 34 of the dew condensation preventing valve 30a(1).

[0029] Similarly, when the piston rod 15 is moved in a return direction by supplying compressed air to the pressure chamber 17a, discharging air in the pressure chamber 17b to the outside, and applying a thrust force to the piston 14 by the compressed air supplied to the pressure chamber 17a, the compressed air supplied from the pipe 23a to the pressure chamber 17a is partially discharged to the outside from the air discharge port 34 of the dew condensation preventing valve 30a (1). In this process, the air in the pressure chamber 17b is partially discharged to the outside from the air discharge port 34 of the dew condensation preventing valve 30a (2) .

[0030] A filter 47 for preventing foreign substances from flowing into the valve element housing hole 32 from the outside is provided in the air discharge port 34 of the spring receiving member 31c.

[0031] FIG. 4 is a timing chart showing operating characteristics of the dew condensation preventing valves 30a (1) and 30a (2) provided to the pneumatic actuator 11. A discharge operation of the pneumatic system 10 at the time of driving the pneumatic actuator 11 will be then described with reference to FIG. 4.

[0032] In the pneumatic actuator 11 shown in FIG. 1, when the fluid channel switching valve 25 is switched

from the position "A" to the position "B" in the state in which the piston rod 15 is returned as shown in FIG. 1, compressed air is supplied from the pipe 23b to the pressure chamber 17b, and the air in the pressure chamber 17a is discharged toward the pipe 23a. As a result, the piston rod 15 is moved to a projection limit position, the pressure of the pressure chamber 17a is reduced, and the pressure of the pressure chamber 17b is increased. On the other hand, when the fluid channel switching valve 25 is switched from the position "B" to the position "A" with the piston rod 15 being at the projection limit position, compressed air is supplied from the pipe 23a to the pressure chamber 17a, and the air in the pressure chamber 17b is discharged toward the pipe 23b. As a result, the piston rod 15 is moved so as to return to a return limit position, the pressure of the pressure chamber 17b is reduced, and the pressure of the pressure chamber 17a is increased.

[0033] When the pressure chamber 17b is at a low pressure, the on-off valve assembly 36 of the dew condensation preventing valve 30a(2) communicated with the pressure chamber 17b is caused to be at the forward limit cutoff position by the spring force of the compression coil spring 41 as shown in FIG. 2A, and the communication between the air intake port 33 and the air discharge port 34 is interrupted. On the other hand, the on-off valve assembly 36 of the dew condensation preventing valve 30a (1) in which the pressure chamber 17a is at a high pressure is caused to be at the backward limit cutoff position by the force of the compressed air, and communication between the air intake port 33 and the air discharge port 34 is interrupted.

[0034] On the other hand, as shown in FIG. 4, when the fluid channel switching valve 25 is switched from the position "A" shown in FIG. 1 to the position "B", the compressed air in the pipe 23b flows toward the pressure chamber 17b, and the air in the pressure chamber 17a flows toward the pipe 23a. When high-pressure compressed air flows into the pressure chamber 17b, the on-off valve assembly 36 of the second dew condensation preventing valve 30a(2) communicated with the pressure chamber 17b is moved from the forward limit cutoff position toward the backward limit cutoff position against spring force. On the other hand, when the air of the pressure chamber 17a is discharged to the pipe 23a, the pressure of the pressure chamber 17a is reduced, the on-off valve assembly 36 of the first dew condensation preventing valve 30a (1) communicated with the pressure chamber 17a is moved from the backward limit cutoff position toward the forward limit cutoff position by the spring force.

[0035] In this moving process, the air intake port 33 and the air discharge port 34 momentarily become an communicated state via the communication section 45, and, as shown in FIG. 4, from the second dew condensation preventing valve 30a(2), the air of the pressure chamber 17b and the air of the part close to the pressure chamber 17b in the pipe 23b is discharged to the outside from the air discharge port 34. Similarly, from the first

dew condensation preventing valve 30a(1), the air of the pressure chamber 17a and the air of the part close to the pressure chamber 17a in the pipe 23a is discharged to the outside from the air discharge port 34. When the on-off valve assembly 36 of the second dew condensation preventing valve 30a(2) is moved to the backward limit cutoff position, the communication between the air intake port 33 and the air discharge port 34 is interrupted. When the on-off valve assembly 36 of the first dew condensation preventing valve 30a(1) is moved to the forward limit cutoff position, the communication between the air intake port 33 and the air discharge port 34 is interrupted, and the piston rod 15 is driven to the projection limit position by thrust force applied to the piston 14.

[0036] When the fluid channel switching valve 25 is switched to the position "A" with the piston rod 15 being at the projection limit position, reverse to the above description, in the process in which the on-off valve assembly 36 of the first dew condensation preventing valve 30a(1) is moved from the forward limit cutoff position to the backward limit cutoff position, the air intake port 33 and the air discharge port 34 momentarily become a communicated state. Furthermore, in the process in which the on-off valve assembly 36 of the second dew condensation preventing valve 30a(2) is moved from the backward limit cutoff position to the forward limit cutoff position, the air intake port 33 and the air discharge port 34 momentarily become a communicated state. As a result, the air of the pressure chamber 17a and the air of the part close to the pressure chamber 17a in the pipe 23a is discharged to the outside from the first dew condensation preventing valve 30a(1), and the air of the pressure chamber 17b and the air of the part close to the pressure chamber 17b in the pipe 23b is discharged to the outside from the second dew condensation preventing valve 30a(2).

[0037] If the reciprocation stroke of the piston rod 15 is short or the cylinder inner diameter is small, the volume in the pipe 23a or 23b from the fluid channel switching valve 25 to the supply and discharge port 21a or 21b is larger than the volume of the pressure chamber 17a or 17b. If the dew condensation preventing valves 30a are not provided, the compressed air in the pressure chamber, which is reduced in pressure, is not discharged to the outside, but remains in the pipe and the pressure chamber and repeats expansion and contraction. Therefore, upon change from the high pressure to the low pressure, the water vapor contained in the compressed air is caused to become liquid by adiabatic expansion and remains in the pressure chamber and the pipe as dew condensation water in some cases.

[0038] On the other hand, in the case in which the dew condensation preventing valves 30a are provided to be communicated with the pressure chambers 17a and 17b, respectively, in the above described manner, when the on-off valve assembly 36 is moved between the forward limit cutoff position and the backward limit cutoff position, part of the high-pressure-side compressed air supplied to the pressure chamber 17a or 17b for applying a thrust

force to the piston 14 is momentarily discharged to the outside, and part of the low-pressure-side compressed air in the pressure chamber 17a or 17b is momentarily discharged to the outside; therefore, part of the air remaining in the pressure chambers and pipes is partially replaced by the air supplied from the compressed air supply 24. As a result, the dryness of the compressed air in the pneumatic system is increased, and occurrence of dew condensation is prevented. Moreover, the air is discharged from both of the pressure chambers to the outside only during the short period of time while the on-off valve assembly 36 is moved between the forward limit cutoff position and the backward limit cutoff position; therefore, although all of low-pressure air in the pressure chamber and the pipe is discharged to the outside by using the conventional techniques, the present invention do not have a potential to allow all of low-pressure air in the pressure chambers and the pipes to be discharged to the outside.

[0039] The on-off valve assembly 36 is moved from the forward limit cutoff position to the backward limit cutoff position when the pressure of the pressure chamber is increased, and the on-off valve assembly 36 is moved from the backward limit cutoff position to the forward limit cutoff position when the pressure of the pressure chamber is reduced. When the pressure of the pressure chamber is increased, the discharged air volume is larger than that of the low pressure. Therefore, as shown in FIG. 4, the discharged air volume in the process in which the on-off valve assembly 36 is moved from the backward limit cutoff position to the forward limit cutoff position is smaller than the discharged air volume in the process in which the on-off valve assembly 36 is moved from the forward limit cutoff position to the backward limit cutoff position.

[0040] If all of the air in the pressure chamber switched to the low pressure state is discharged to the outside via a check valve across an all-discharge stroke, which discharges low-pressure air, like conventional techniques when the pressure chamber is switched from a high pressure state to a low pressure state, the air in the pipe cannot be used for next pressurization. On the other hand, if it is configured to be momentarily discharged to the outside, the low-pressure-side air remaining in the pipe and the pressure chamber can be also utilized as the air to be supplied to the pressure chamber; therefore, the volume of the compressed air used in the pneumatic system can be reduced. Particularly, in a manufacturing line of electronic parts, many pneumatic actuators 11 are used, and the volume of the compressed air supplied from the compressed air supply(s) 24 to all of the pneumatic actuators 11 is massive. However, when the air volume discharged from the pneumatic actuator 11 to the outside can be reduced as described above, the volume of the compressed air supplied to all of the pneumatic systems 10 can be significantly reduced. Since the used volume of the compressed air is suppressed, the power consumption for the compressor (s) for generating compressed air can be reduced, and occurrence of dew

condensation in the pneumatic systems can be prevented while effectively utilizing the air in the pipes.

[0041] The pneumatic actuator 11 shown in FIG. 1 is a double-acting type configured to apply thrust force of the compressed air to the piston 14 in both of the cases in which the piston rod 15 is subjected to projecting movement and returning movement. On the other hand, if thrust force of the compressed air is applied to the piston 14 upon movement of either one of the projecting movement and returning movement of the piston rod 15, and thrust force is configured to be applied to the piston 14 by a spring member upon the other movement, the pneumatic actuator is a single-acting type. In the case of such a single-acting type, the single dew condensation preventing valve 30a is attached to the pneumatic actuator.

[0042] FIG. 5 is a sectional view showing one variation of the dew condensation preventing valve provided to the pneumatic actuator, and FIG. 6 is an enlarged sectional view of the dew condensation preventing valve shown in FIG. 5.

[0043] In the pneumatic actuator 11 shown in FIG. 5 and different from that of FIG. 1, dew condensation preventing valves 30b are provided so as to correspond to the pressure chambers 17a and 17b, are connected to the pipe connecting sections 22a and 22b of the supply and discharge ports 21a and 21b for supplying to and discharging compressed air from the pressure chambers 17a and 17b. The pneumatic actuator 11 is the same in basic structure as that of FIG. 1, and different from that of FIG. 1 in that the casing 12 shown in FIG. 5 is not provided with communication holes 35a and 35b communicating with the pressure chambers 17a and 17b. The dew condensation preventing valves 30b are the same in structure as each other, as shown in FIG. 5, "(1)" is added to the reference character "30b" of one of the dew condensation preventing valves, and "(2)" is added to the reference character "30b" of the other of the dew condensation preventing valves.

[0044] As shown in FIG. 6, a valve housing 31 of each of the dew condensation preventing valves 30b has: a cylindrical section 31a; and a joint section 31d integrally formed with this section. The joint section 31d is provided with an air intake port 33 which opens on the outer peripheral surface of the valve element housing hole 32, a communication port 51 is provided so as to correspond to the air intake port 33 and opens to the outer peripheral surface of the valve element housing hole 32, and the air intake port 33 and the communication port 51 are positioned at distal ends of the valve element housing hole 32. A pipe connecting part 52 communicated with the air intake port 33 and a pipe connecting part 53 communicated with the communication port 51 are provided at the joint portion 31d. The pipe connecting part 22a of the pneumatic actuator 11 is connected to the pipe connecting part 52 of the dew condensation preventing valve 30b(1) by a communication pipe 54a, and the pipe connecting part 22b is connected to the pipe connecting part 52 of the dew condensation preventing valve 30b(2) by

a communication pipe 54b. In this manner, the valve housings 31 of the dew condensation preventing valves 30a and 30b are attached to the casing 12 of the pneumatic actuator 11 by the communication pipes 54a and 54b. On the other hand, the pipe 23a connected to the compressed air supply 24 via the fluid channel switching valve 25 is connected to the pipe connecting part 53 of the dew condensation preventing valve 30b(1), and the pipe 23b is connected to the pipe connecting part 53 of the dew condensation preventing valve 30b(2). Therefore, the dew condensation preventing valves 30b also function as coupling members for attaching the pipes 23a and 23b to the casing 12, respectively.

[0045] Although the casing 12 of the pneumatic actuator 11 shown in FIG. 1 is provided with screw holes and communication holes 35a and 35b to which the male screw sections 31b of the dew condensation preventing valves 30a are respectively attached, since the dew condensation preventing valves 30b of this case respectively function as coupling members, it is not necessary to provide, to the casing 12 of this case, screw holes and communication holes 35a and 35b to which the male screw sections 31b of the dew condensation preventing valves 30a are respectively attached, and it is possible to attach the dew condensation preventing valves 30a to the conventional pneumatic actuator when needed.

[0046] Also in the pneumatic system shown in FIG. 5, when the on-off valve assembly 36 is moved between the forward limit cutoff position and the backward limit cutoff position, part of the high-pressure-side compressed air supplied to the pressure chamber 17a or 17b for applying thrust force to the piston 14 is momentarily discharged to the outside, and part of low-pressure-side compressed air is momentarily discharged to the outside. Therefore, the air in the pressure chamber is sent toward the air discharge port 34 via the communication pipe 54a or 54b, part of the air remaining in the pipe 23a or 23b is also sent toward the air discharge port 34, and the inside of the pressure chamber and the pipe is partially replaced by the air supplied from the compressed air supply 24 by high-pressure-side compressed air. As a result, the dryness of compressed air in the pneumatic system is increased, and occurrence of dew condensation is prevented. Moreover, the air is discharged to the outside from both of the pressure chambers only in a short period of time, that is, only when the on-off valve assembly 36 is moved between the forward limit cutoff position and the backward limit cutoff position. Therefore, although all of low-pressure air in the pressure chambers and the pipes is discharged to the outside in the conventional techniques, the present invention do not have a potential to allow all of low-pressure air in the pressure chambers and the pipes to be discharged to the outside.

[0047] The pneumatic actuator 11 shown in FIG. 5 is the double-acting type, and the pressure chambers 17a and 17b are provided in both sides of the piston 14. On the other hand, in a pneumatic actuator of the single-acting type, a pressure chamber is formed in one side of

the piston 14; therefore, the single dew condensation preventing valve 30b is attached to the casing 12. Additionally, in the pneumatic system shown in FIG. 5, if either the pipe connecting parts 22a and 22b or the pipe connecting parts 52 are formed as male screw portions, the valve housings 31 can be directly screwed to the casing 12 without using the communication pipes 54a and 54b.

[0048] FIG. 7 is a cross-sectional view showing another variation of the dew condensation preventing valve. A valve housing 31 of a dew condensation preventing valve 30c shown in FIG. 6 has a cylindrical section 31a and a joint portion 31d integrated therewith as well as the dew condensation preventing valves 30b shown in FIG. 5 and FIG. 6. The joint portion 31d is provided with an air intake port 33 which is open to the abutting surface 39a of the valve element housing hole 32, and the pipe connecting parts 52 and 53 are communicated with an outer end of the air intake port 33. When two dew condensation preventing valve 30c shown in FIG. 7 are attached to the pneumatic actuator 11, as well as the case shown in FIG. 5, the pipe connecting part 52 of one of the dew condensation preventing valve 30c is connected to the pipe connecting part 22a by the communication pipe 54a, and the pipe connecting part 52 of the other dew condensation preventing valve 30c is connected to the pipe connecting part 22b by the communication pipe 54b.

[0049] FIG. 8A is a sectional view showing still another variation of the dew condensation preventing valve with the on-off valve assembly taking the backward limit cutoff position, FIG. 8B is a sectional view showing the dew condensation preventing valve with the on-off valve assembly taking the forward limit cutoff position, and FIG. 8C is a sectional view showing the dew condensation preventing valve with the on-off valve assembly being on the way to the forward limit cutoff position or the backward limit cutoff position.

[0050] The valve housing 31 of this dew condensation preventing valve 30d has, in the same manner as the dew condensation preventing valve 30a shown in FIG. 1, a cylindrical section 31a and a male screw section 31b, a valve shaft 37 movably attached in the valve element housing hole 32 is provided with one valve supporting section 38, and the valve supporting section 38 is provided with a valve seal member 46. The valve housing 31 is provided with first and second valve seat surfaces 42a and 42b distant from each other in the axis direction. A communication section 45a larger in diameter than each valve seat surface is provided between the valve seat surfaces 42a and 42b.

[0051] In the dew condensation preventing valve 30d shown in FIG. 8, when the on-off valve assembly 36 is at the backward limit cutoff position as shown in FIG. 8A, the valve seal member 46 of the valve supporting section 38 is in contact with the first valve seat surface 42a between the communication section 45a and the air discharge port 34, and the communication between the air intake port 33 and the air discharge port 34 is interrupted. On the other hand, when the on-off valve assembly 36

is at the forward limit cutoff position as shown in FIG. 8B, the valve seal member 46 is in contact with the second valve seat surface 42b between the communication section 45a and the air intake port 33, and the communication between the air intake port 33 and the air discharge port 34 is similarly interrupted. On the other hand, when the on-off valve assembly 36 is moved between the forward limit cutoff position and the backward limit cutoff position, wherein the valve supporting section 38 passes the communication section 45a, as shown in FIG. 8C, the valve seal member 46 is not in contact with the valve seat surfaces 42a and 42b, and the state in which the air intake port 33 and the air discharge port 34 are communicated with each other via the communication section 45a is obtained. As a result, when compressed air is supplied to the pressure chamber to apply a thrust force to the piston 14 by compressed air and move the piston rod 15, part of the high-pressure side compressed air supplied to one of the pressure chambers and part of the low-pressure side compressed air discharged from the other pressure chamber are momentarily discharged to the outside from the air discharge ports 34 of the dew condensation preventing valves 30d.

[0052] The dew condensation preventing valves 30c and 30d shown in FIG. 7 and FIG. 8 can be also attached to the pneumatic actuators of the double-acting type and the single-acting type.

[0053] The present invention is not limited to the above described embodiments, and various modifications can be made within a range not departing from the gist thereof. For example, FIG. 1 and FIG. 5 show the pneumatic actuators 11 configured to drive the piston rod 15 serving as a reciprocating member. However, if the dew condensation preventing valve is attached to a swinging actuator which is configured to be driven by compressed air while using a rotating member, which swings and reciprocates, as a reciprocating member, dew condensation in a pneumatic system having a swinging actuator, i.e., a rotary actuator can be prevented from occurring.

Claims

1. A dew condensation preventing valve for preventing occurrence of dew condensation in a pneumatic system provided with: a pneumatic actuator having a pressure chamber to which compressed air is supplied; and a pipe through which compressed air is supplied from a compressed air supply to the pressure chamber, comprising:

a valve housing provided with a valve element housing hole which opens into an air intake port communicating with the pressure chamber, and opens into an air discharge port communicating with outside;

an on-off valve assembly provided to the valve housing, reciprocable between a forward limit

- cutoff position and a backward limit cutoff position, and configured to prevent the air intake port and the air discharge port from communicating with each other at the forward limit cutoff position and the backward limit cutoff position;
 a spring member for applying a spring force to the on-off valve assembly toward the forward limit cutoff position; and
 a communication section provided to the valve housing, and configured to cause the air intake port and the air discharge port to communicate with each other when the on-off valve assembly is positioned between the forward limit cutoff position and the backward limit cutoff position.
2. The dew condensation preventing valve according to claim 1, wherein the on-off valve assembly has:
- a first valve seal member for preventing the communication section and the air discharge port from communicating with each other when the on-off valve assembly reaches the forward limit cutoff position; and
 a second valve seal member for preventing the air intake port and the communication section from communicating with each other when the on-off valve assembly reaches the backward limit cutoff position.
3. The dew condensation preventing valve according to claim 1, wherein,
 when the on-off valve assembly reaches the backward limit cutoff position, the on-off valve assembly comes in contact with a first valve seat surface between the communication section and the air discharge port, and
 when the on-off valve assembly reaches the forward limit cutoff position, the on-off valve assembly comes in contact with a second valve seat surface between the air intake port and the communication section.
4. The dew condensation preventing valve according to any one of claims 1 to 3, wherein
 the valve housing has a male screw section provided with the air intake port, the valve housing being attached to the pneumatic actuator by the male screw section.
5. The dew condensation preventing valve according to any one of claims 1 to 3, wherein
 the valve housing has a joint section provided with the air intake port; the valve housing being connected to the pneumatic actuator by a communication pipe through which a supply and discharge port, through which compressed air is supplied to the pressure chamber or discharged from the pressure chamber, and the joint section are connected.
6. The dew condensation preventing valve according to any one of claims 1 to 5, wherein
 the pneumatic actuator has a casing in which a piston provided with a piston rod which is linearly reciprocated is accommodated, and
 the pneumatic actuator is provided with: a returning side pressure chamber for applying a thrust force to the piston in a returning direction of the piston rod; and a protruding side pressure chamber for applying a thrust force to the piston in a protruding direction of the piston rod,
 the returning side pressure chamber and the protruding side pressure chamber communicate with the dew condensation preventing valve.

FIG. 1

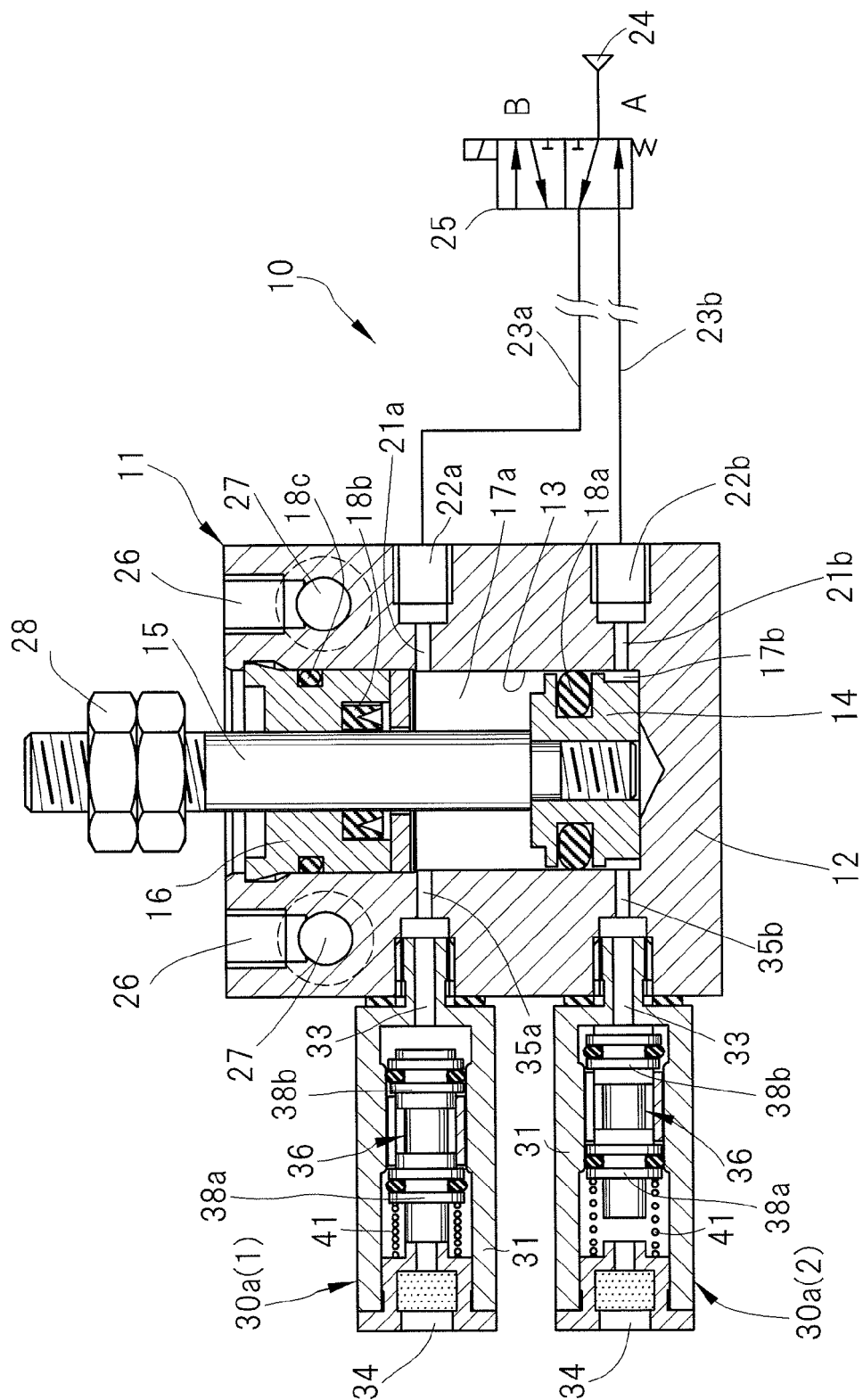


FIG. 2A

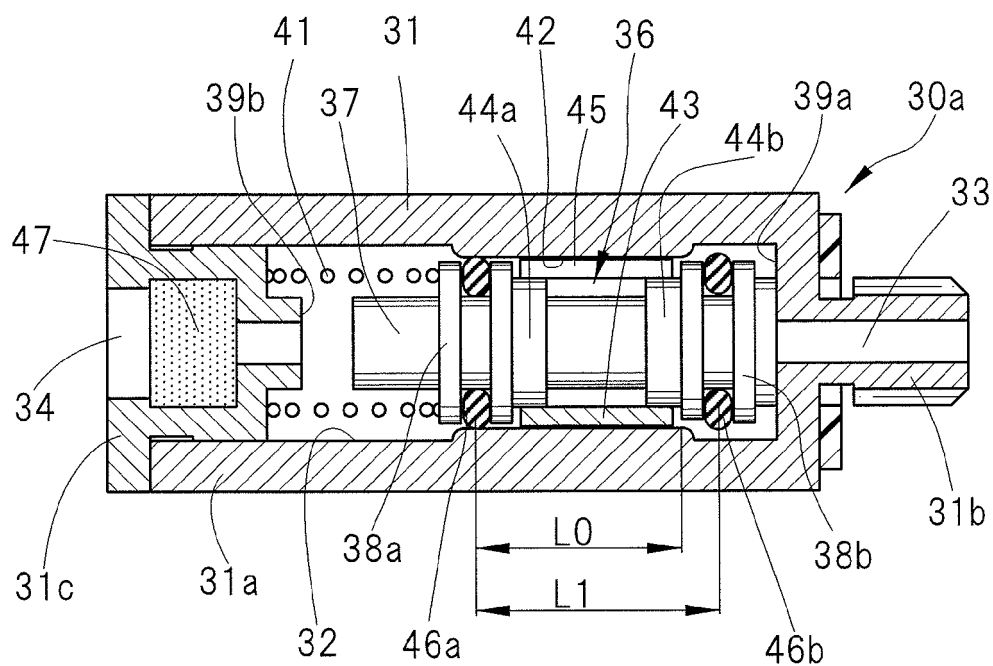


FIG. 2B

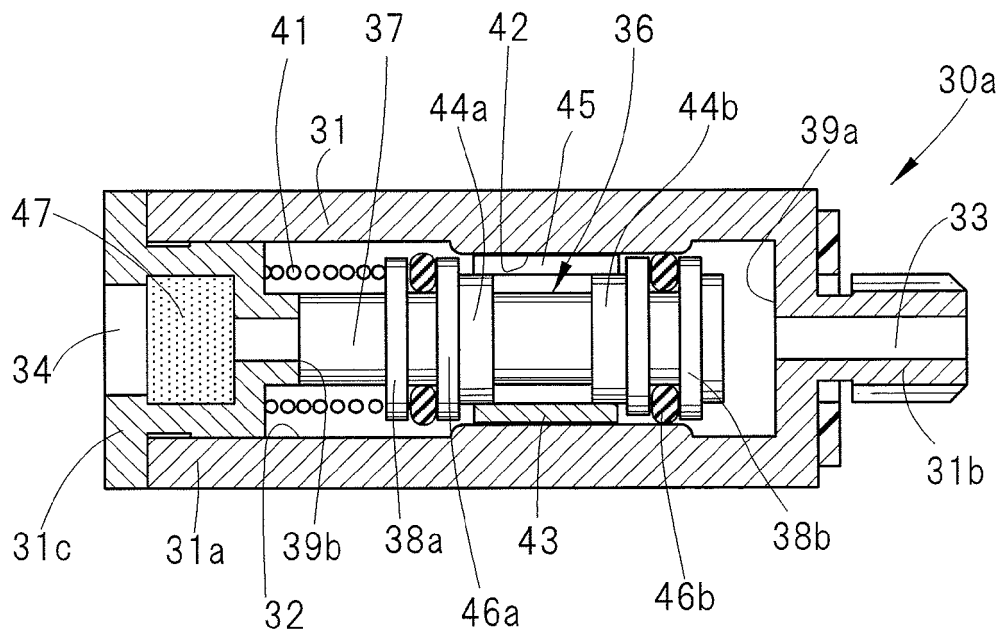


FIG. 3A

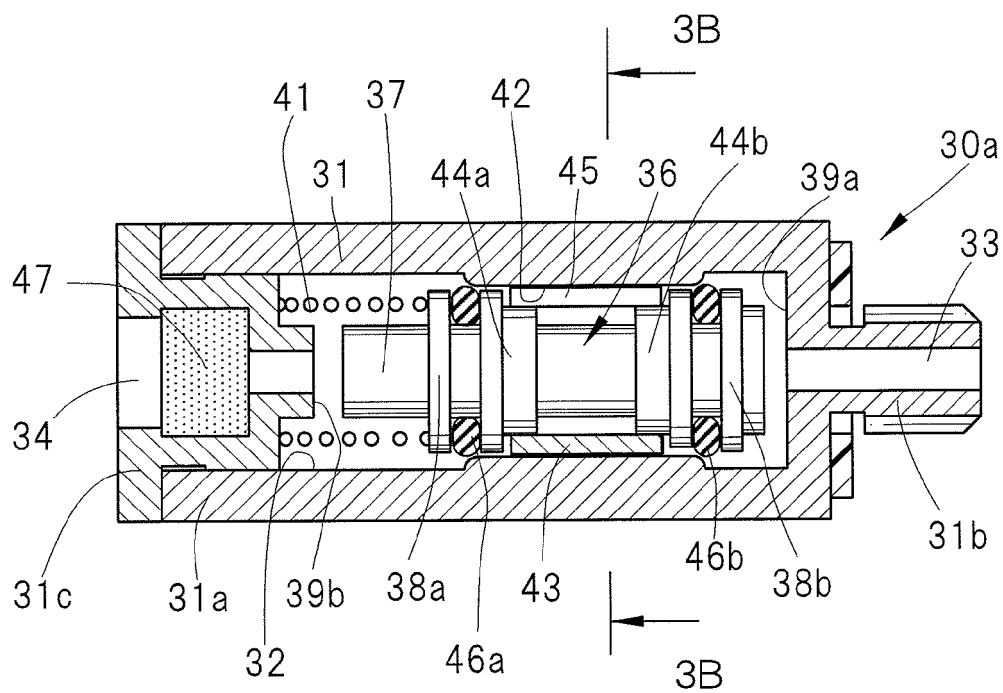


FIG. 3B

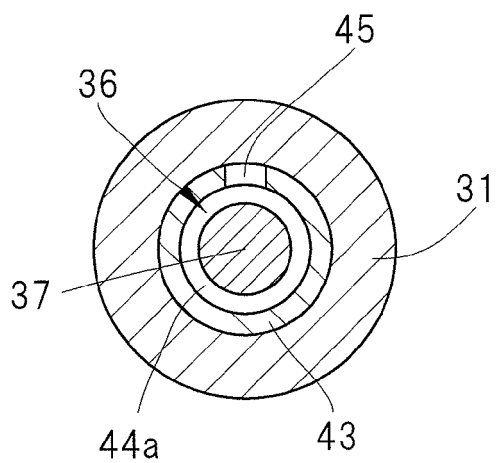


FIG. 4

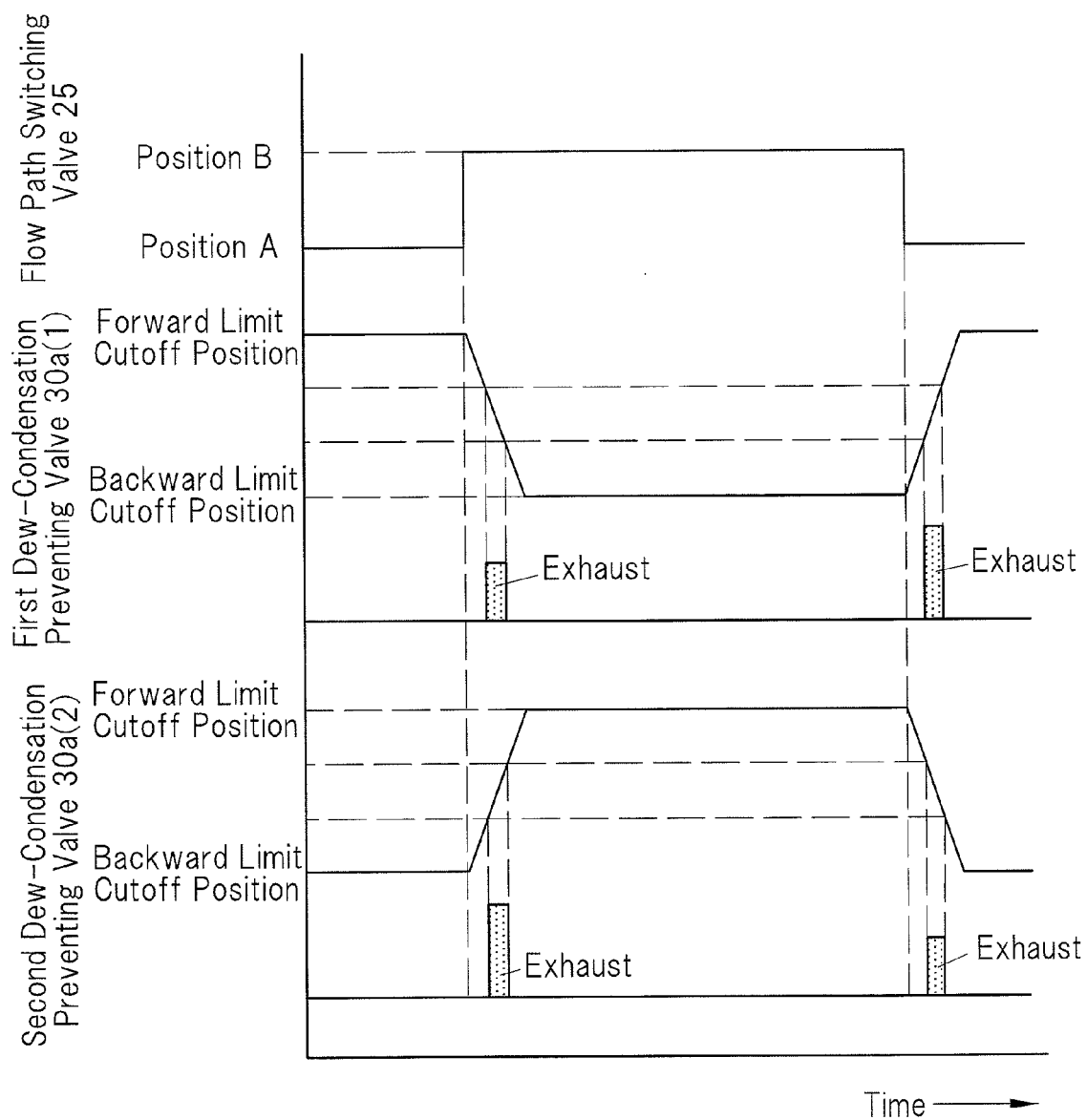


FIG. 5

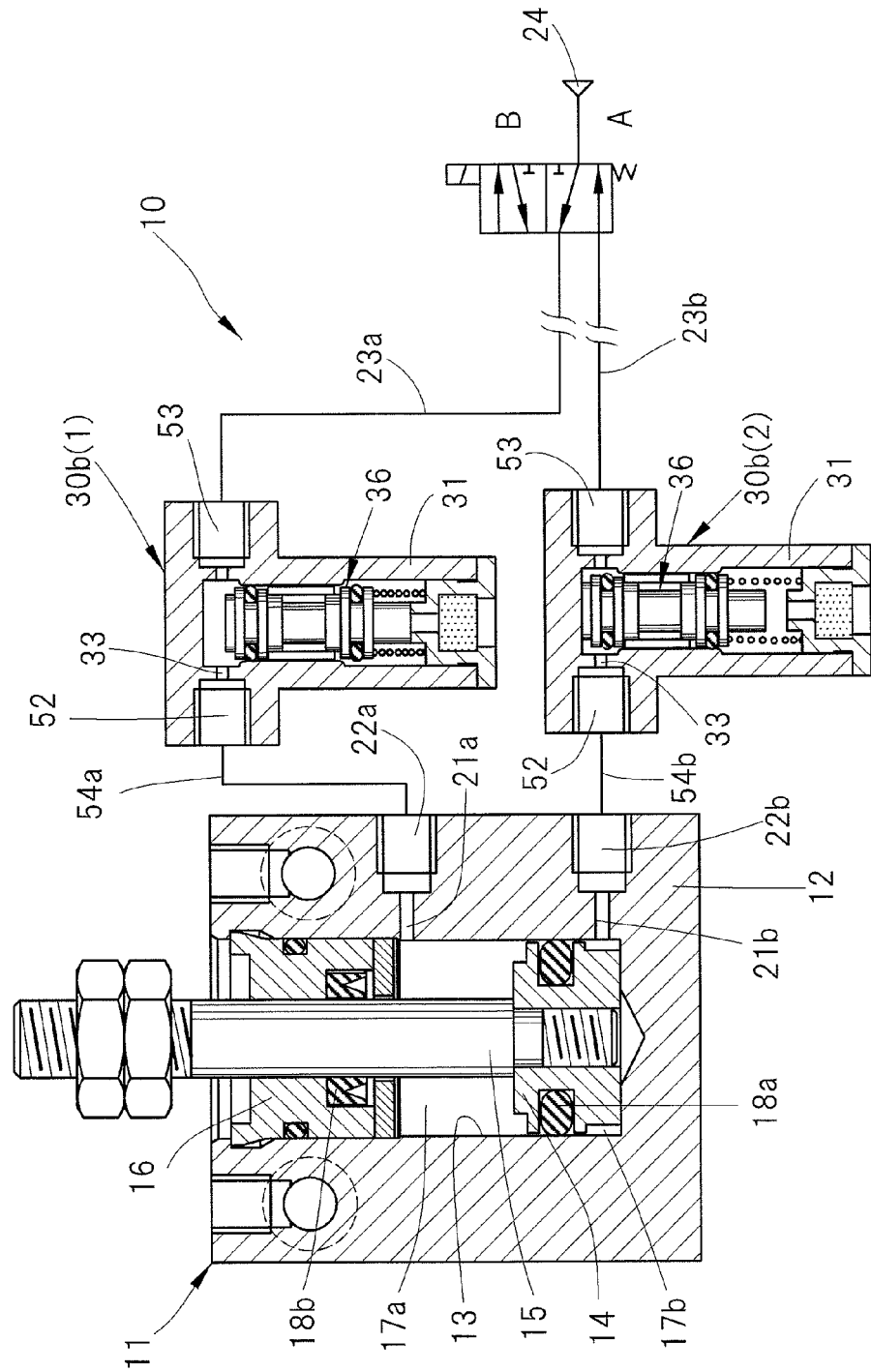


FIG. 6

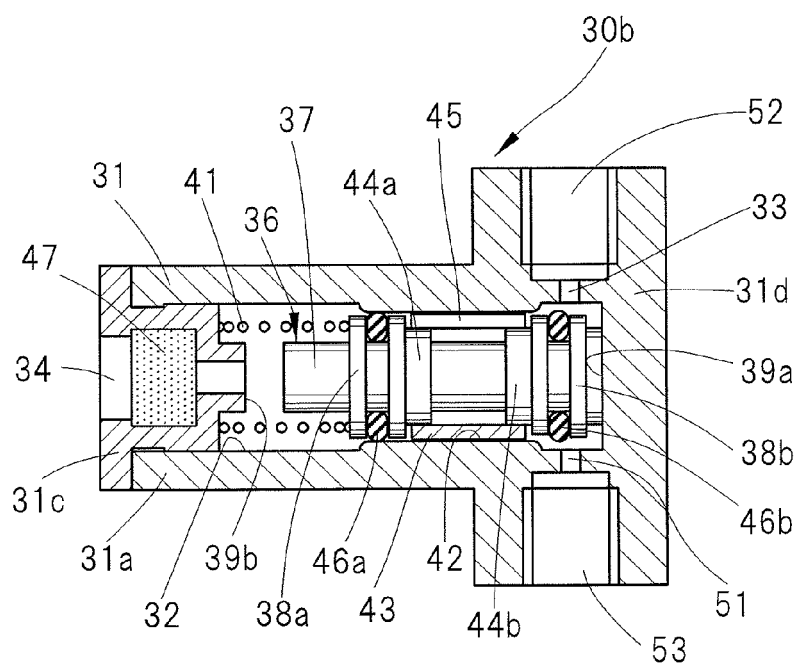


FIG. 7

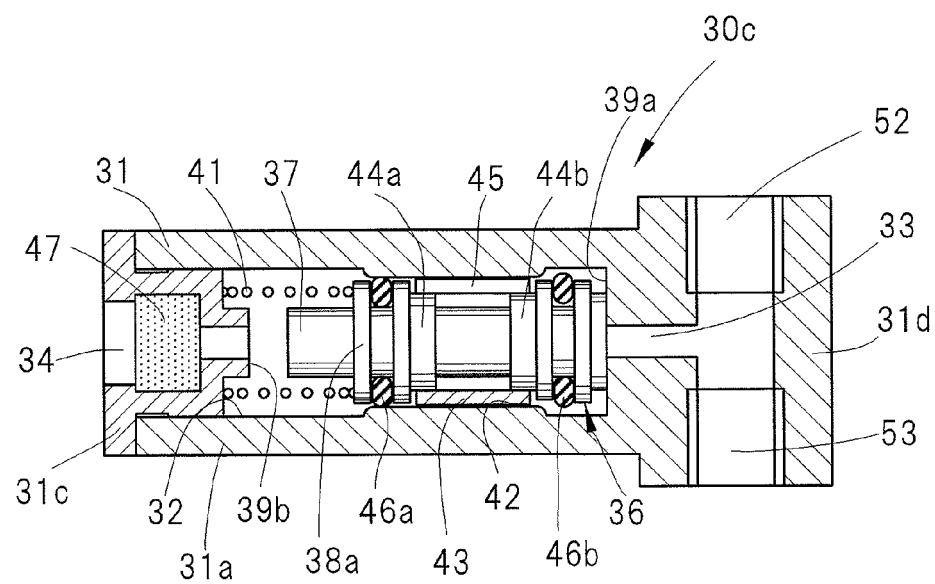


FIG. 8A

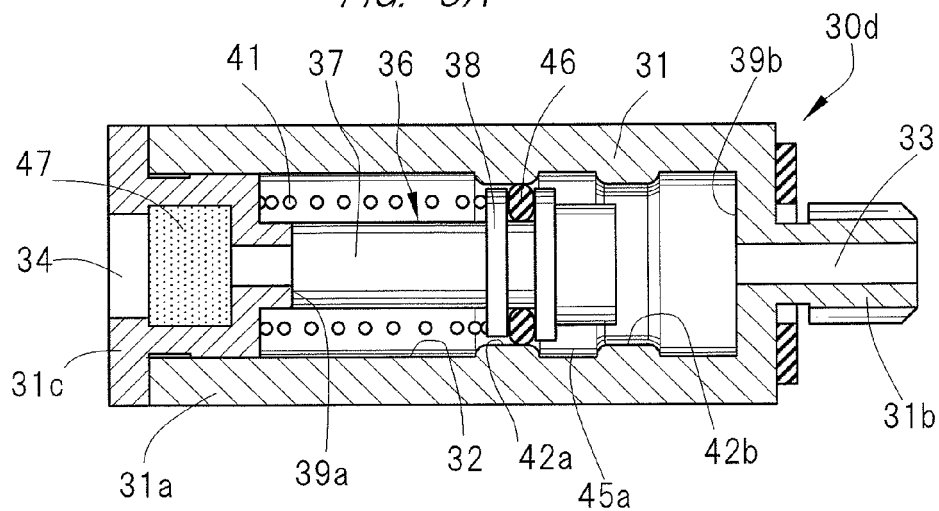


FIG. 8B

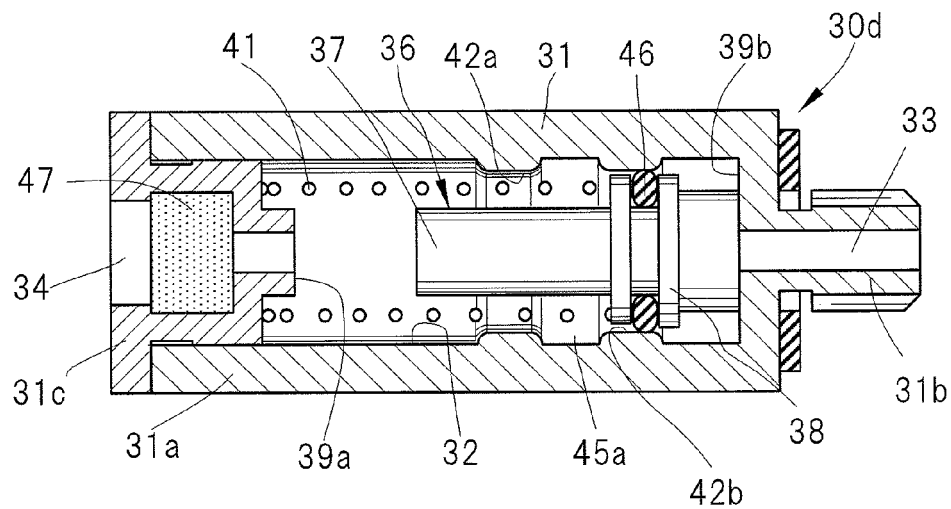
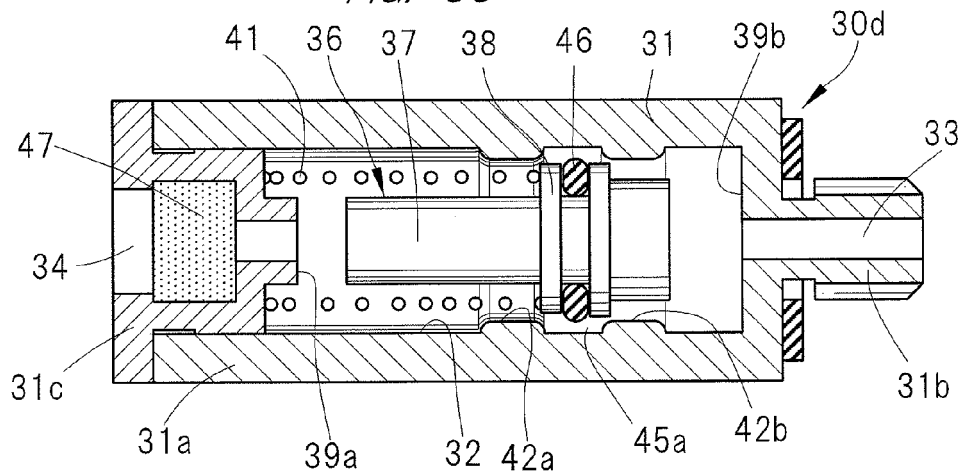


FIG. 8C





EUROPEAN SEARCH REPORT

 Application Number
 EP 14 16 4009

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	US 2010/032036 A1 (QUENDT VOLKER [DE] ET AL) 11 February 2010 (2010-02-11) * paragraph [0023] - paragraph [0043]; figures 1-3 *	1-6	INV. F15B11/06 F15B21/00 F16K1/44
A,D	JP S54 165686 U (KOGANEI) 20 November 1979 (1979-11-20) * figures 1-5 *	1-6	
A	EP 1 830 098 A1 (KOGANEI LTD [JP]) 5 September 2007 (2007-09-05) * figures 1-11 *	1-6	
A	EP 2 434 226 A2 (KERMI GMBH [DE]) 28 March 2012 (2012-03-28) * figures 1-8 *	1-6	
A	US 6 263 900 B1 (CABRERA MARIO D [US] ET AL) 24 July 2001 (2001-07-24) * figure 13 *	1	
A	WO 2012/108140 A1 (TGK CO LTD [JP]; HIROTA HISATOSHI [JP]) 16 August 2012 (2012-08-16) * figures 1-7 *	1	TECHNICAL FIELDS SEARCHED (IPC) F15B F16K
The present search report has been drawn up for all claims			
Place of search Munich		Date of completion of the search 30 July 2014	Examiner Heneghan, Martin
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 14 16 4009

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.

30-07-2014

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 2010032036 A1	11-02-2010	BR PI0720743 A2 CA 2659165 A1 CN 101688616 A EP 2047153 A1 US 2010032036 A1 WO 2009003500 A1	26-02-2013 08-01-2009 31-03-2010 15-04-2009 11-02-2010 08-01-2009
JP S54165686 U	20-11-1979	JP S5847292 Y2 JP S54165686 U	28-10-1983 20-11-1979
EP 1830098 A1	05-09-2007	EP 1830098 A1 JP 4971828 B2 JP 2007263362 A KR 20070090776 A TW I331193 B US 2007205065 A1 US 2012326367 A1	05-09-2007 11-07-2012 11-10-2007 06-09-2007 01-10-2010 06-09-2007 27-12-2012
EP 2434226 A2	28-03-2012	DE 102010046169 A1 EP 2434226 A2 RU 2011138077 A	29-03-2012 28-03-2012 27-03-2013
US 6263900 B1	24-07-2001	NONE	
WO 2012108140 A1	16-08-2012	JP 2012163259 A WO 2012108140 A1	30-08-2012 16-08-2012

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 2013089616 A [0001]
- JP H04116004 B [0006]
- JP S54165686 B [0006]
- JP H10009205 B [0006]