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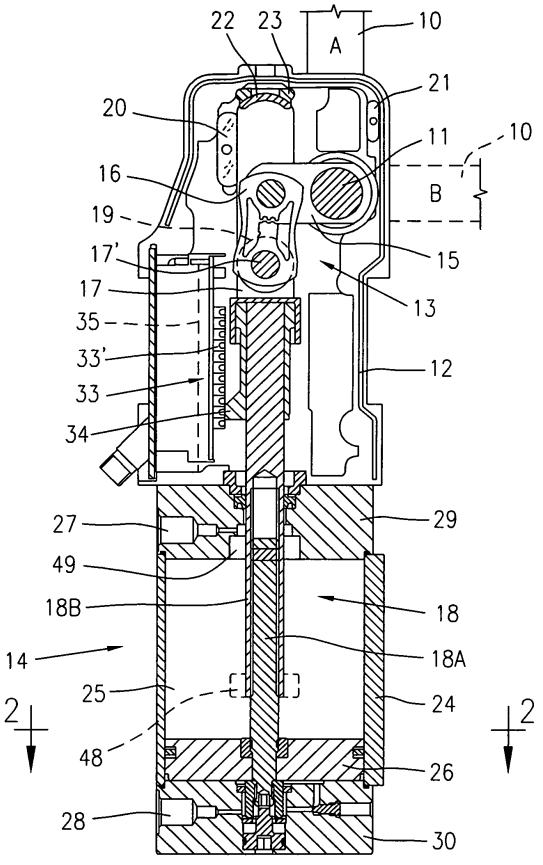
(54) Positioning and/or clamping apparatus, with adjustable opening position of the working arm

(57) An apparatus for positioning a tool and/or clamping a work piece; the apparatus comprises a working arm (10) angularly rotatable between a plurality of opening positions (A) and a closed position (B) against a work piece. A linear pneumatic actuator (14) is operatively connected to the working arm (10) by means of a toggle-lever drive device (13); the pneumatic actuator (14) comprises a single piston (26) connected to the toggle-lever device (13) by means of a threadingly extensible piston rod (18), which is adjustable in length to change the opening angle of the working arm (10). A drive member (36) operatable from the outside is selectively engagable with the piston rod (18) to adjust its axial length.

Fig. 1



EP 1 849 559 A1

Description

BACKGROUND OF THE INVENTION

[0001] This invention refers to a drive apparatus having a rotatable working arm, used for example in the motor vehicle manufacturing field for assembling parts of the bodywork; in particular the invention refers to an apparatus for clamping work pieces, or for positioning a work piece or a tool, for example for arc welding or for other similar applications, by means of which it is possible to continuously adjust the opening angle of the working arm.

[0002] Drive apparatuses of the aforementioned kind, capable of enabling the adjustment of the opening angle of a working arm, are known for example from US-A-6,220,588 and WO-A 2005/044517; according to these documents, the pneumatic actuator comprises two pistons movable with respect to each other, disposed in such a way as to vary the working stroke by appropriately regulating their distance, in relation to the required opening angle.

[0003] In particular, in US-A-6,220,588 a first working piston is provided, having a non-extensible rod of a preestablished length, connected to the working arm by a toggle-lever device, in a per se known way; the actuator comprises a second stop and brake piston whose position may be changed to vary the stroke of the working piston, and consequently to vary the angle of rotation upon the opening of the working arm by acting on an adjusting screw.

[0004] WO-A-2005/044517 in turn proposes a drive apparatus again comprising two jointly movable pistons connected to the working arm by means of a non-extensible rod and a toggle-lever device; the reciprocal distance between the two pistons may be varied also by acting on an adjusting screw connecting the pistons. Also in this case the adjustment of the opening angle of the working arm is obtained by simply varying the working stroke of the actuator, by adjusting the reciprocal position of the pistons.

[0005] US-A-6,416,045 and US-A-6,616,133, illustrate two clamping apparatuses of the aforementioned kind, in which the adjustment of the opening angle of the working arm is carried out by steps, by adjusting the axial length of the rod of the actuator.

[0006] According to US-A-6,416,045, the rod comprises two coaxial rods, sliding one inside the other, in which the internal rod is provided with a plurality of cross holes which can be aligned with corresponding cross holes in the external rod, for the insertion of a locking pin, thereby enabling the step-by-step adjustment of the length of the rod of the actuator, and consequently the discontinuous variation of the angle of rotation of the working arm, a fine or continuous adjustment being not obtainable.

[0007] US-A-6, 616, 133, in turn, suggests the use of an actuator again comprising a step-by-step extensible rod, in which the internal rod has a plurality of circular slots, and in which use is made of a cam device selectively engageable in the slots in the internal rod to adjust the length of the rod step by step.

[0008] These documents also propose complex and costly solutions, with which it is only possible to obtain a discontinuous adjustment of the length of the rod of the actuator, and consequently of the opening angle of the working arm. Moreover, for both these solutions it is necessary to open the apparatus to adjust the length of the rod, which is not always possible or is complicated and time-consuming when apparatuses of this kind are installed along a processing line.

[0009] All this results in a complexity of the system due to the need to make use of and operate different types of apparatuses, with differentiated working strokes, to satisfy the different operative requirements of the users.

[0010] Lastly, EP-A-0908272 illustrates a clamping apparatus of the aforementioned kind, in which the pneumatic actuator comprises an axially extensible rod, substantially composed of a first threaded element rigidly connected to the rod of the piston, which engages by screwing with a second threaded element connected to the working arm by means of a toggle-lever device.

[0011] This document, which represents the closest prior art to this invention, in accordance with the preamble of claim 1, again proposes a somewhat unpractical and complex solution, in that, in order to adjust the length of the rod, it is necessary to separate the actuator from the box-shaped body of the device, and then rotate it by the desired degree.

[0012] An adjustment of the rod, by rotating the actuator, can be difficultly carried out after the apparatus has been installed along a processing line; moreover, it is not practically possible to achieve a continuous adjustment due to the need to align the stay bolts of the actuator with the threaded holes in the box-shaped body of the toggle-lever device which transforms the linear movement of the actuator into a rotary movement of the working arm.

OBJECTS OF THE INVENTION

[0013] The main object of the invention is to provide a drive apparatus of the aforementioned kind, which is structurally simple, highly reliable and which at the same time enables the adjustment of the opening angle of the working arm within a wide range of values, without having to open or remove the apparatus itself, once installed along a processing line, also when operated with compressed air; conversely, the operator should manually position the working arm in the required position.

[0014] A still further object of the invention is to provide a drive apparatus, as mentioned previously, which is practically an universal apparatus in that it offers the possibility of continuously adjusting the opening angle of the working arm, within a field of values ranging for example from 0° to 135°, making use of a normal ISO cylinder, without requiring special actuators.

[0015] A still further object is to provide a drive apparatus for the aforementioned uses, provided with an au-

tomatic system for sensing the angular positions of the working arm, capable of allowing the self-learning of any chosen position, for example as described in EP-A-1,623,795, incorporated herein for reference.

BRIEF DESCRIPTION OF THE INVENTION

[0016] These and further objects of the invention can be achieved by means of a drive apparatus with adjustable angular opening position of a working arm, according to claim 1.

[0017] In particular, according to the invention, a drive apparatus for clamping a work piece and/or positioning a work piece or a tool, comprising:

a box-shaped body having a longitudinal axis;
a working arm rotatably supported by the box-shaped body, to rotate between a first angular opening position and a second angular closing position for clamping a work piece and/or positioning a work piece or tool;
a linear pneumatic actuator secured at one end of the box-shaped body, said pneumatic actuator comprising a single piston member reciprocable in a piston chamber, said piston member having an axially extensible rod comprising a first threaded element connected to the piston member, and a second threaded element having a front end hingedly connected to a toggle-lever system operatively connected to the working arm, said first threaded element being threadingly engageable with the second threaded element to selectively change the axial space between the piston member and the hinged connection; and
sensing means for detecting opening positions of the working arm,
characterised in that the first threaded element is rotatably secured to the piston member of the actuator, the second threaded element extending into the piston chamber with a rear end axially spaced apart from the piston member;
externally operable rod-length adjusting means being provided, said rod-length adjusting means comprising a drive member rotatably supported at one end of the actuator, said drive member being selectively engageable with and disengageable from the first threaded element to rotate the same first threaded element of the piston rod;
work-arm stop means being arranged inside the box-shaped body for stopping the working arm in the closing position; and
in that said sensing means comprise a plurality of sensors actuated by the piston rod, said sensor being parallely arranged to the longitudinal axis inside the box-shaped body to detect the work arm in a plurality of angularly spaced apart positions of the same working arm.

BRIEF DESCRIPTION OF THE DRAWINGS

[0018] These and further features of the apparatus according to the invention, will be more clearly evident from the following description with reference to the drawings, in which:

Fig. 1 shows a longitudinal cross-sectional view of the apparatus according to the invention;
Fig. 2 shows a cross-sectional view along the line 2-2 of Fig. 1;
Fig. 3 shows an enlarged detail of Fig. 1;
Fig. 4 shows an enlarged detail of the damping system and of the adjusting system for adjusting the length of the piston rod.

DETAILED DESCRIPTION OF THE INVENTION

[0019] As shown in figure 1, the drive apparatus comprises a working arm 10 connected to a shaft 11 rotatably supported by a box-shaped body 12 having a longitudinal axis; the apparatus also comprises a toggle-lever drive device or system 13 inside the box shaped body 12 and a linear pneumatic actuator 14, operatively connected to the working arm 10 by means of the same toggle-lever device 13 to transform the linear movement of the piston of the actuator 14, into a rotating movement of the working arm 10 between a first suitably adjustable opening position A and a second closing position B in which the working arm B positions a work piece, or a tool, not shown, against a work piece, or clamps the latter against a supporting surface, along a processing line.

[0020] The toggle-lever device 13 comprises a crank 15, connected to the work-arm shaft 11, and an intermediate connecting link 16, which in turn is hingedly connected to a rod 18 of the actuator 14 by a hinge pin 17' provided between the same link 16 and a connecting element 17 arranged at a front end of the rod 18.

[0021] The reference number 19 in figure 1 has been used to indicate one of the two guide rollers coaxially arranged onto the hinge pin 17' between the connecting link 16 and the connecting element 17; the roller 19 is movable along a raceway parallel to the rod of the actuator 14, the raceway extending with a cam 20 having a linear, or appropriately arched, profile to provide the reaction necessary to generate the force for closing the arm 10 in the position B.

[0022] Lastly, in Fig. 1 the reference number 21 has been used to indicate a work-arm stop element for stopping the crank 15, defining the exact closing position B of the working arm 10. The reference number 22 has been used to indicate an elastic pad secured to a second stop element 23 axially aligned with the actuator 14, whose absence or presence makes the system reversible or irreversible, under the action of external forces, according to need.

[0023] The linear pneumatic actuator 14 is of the double-acting type; it comprises a cylinder 24 having an oval-

shaped chamber 25, in which reciprocates a single piston member 26; compressed air can be fed and, respectively, discharged on the two sides of the chamber 25 of the cylinder 24, through inlet/discharge apertures 27, 28 made in the two heads 29 and 30 which close the cylinder 24 at the two ends.

[0024] As mentioned previously, the pneumatic actuator 14 comprises a rod 18 which extends axially into the box-shaped body 12 for an operative connection with the toggle-lever drive device 13.

[0025] According to this invention, in order to allow a continuous variation and adjustment of the angular opening position A of the working arm 10 within a wide range of values, ranging for example from 0° to 135°, by means of a simple, highly reliable and fail-safe solution, in combination with a linear pneumatic actuator of the conventional type, use has been made of a rod 18 made in such a way as to be axially extensible simply by screwing, so as to allow it to be adjusted in length acting from the outside without having to open or remove the actuator.

[0026] According to the example of Fig. 1, the rod 18 comprises a first threaded element 18A which threadingly engages with a second threaded element 18B in order to selectively change the axial space between the piston 26 and the hinge pin 17'; both the elements 18A and 18B are provided with a screw thread having a pitch capable of allowing a fine adjustment of the axial length of the rod 18, and an irreversible coupling between the screw threads under the action of axial thrusts of the piston 26 and of external forces.

[0027] In particular, the first threaded element 18A is secured to the piston 26 in such a way as to be able to rotate around its own longitudinal axis, by acting from the outside of the actuator, as explained further on with reference to Fig. 4.

[0028] The second threaded element 18B, as previously mentioned, has a front end hingedly connected to the toggle-lever system 13; furthermore, the same element 18B tightly extends from the box-shaped body 12 into the piston chamber 25 with a rear end axially spaced apart from the piston 26.

[0029] In the example shown, the first threaded element 18A and the second threaded element 18B are threadingly engaged with each others, since the threaded element 18A is screwed into an internally threaded hole in the second threaded element 18B.

[0030] As shown in Fig. 1 and in the enlarged detail of Fig. 3, in order to prevent any accidental rotations of the threaded element 18A, with respect to the threaded element 18B, caused for example by vibrations to which the entire apparatus may be subjected during operation, use has been made of a suitable friction means, for example consisting of a cylindrical plug 31, made of plastic material or other suitable material, housed in a cross hole 32 near to the front end of the threaded element 18A; the plug 31 has an axial length slightly greater than the diameter of the internal threaded element 18A so as to frictionally interfere with the screw thread of the threaded element 18B.

[0031] As previously mentioned, the invention is directed to a drive apparatus comprising a toggle-lever device and a linear pneumatic actuator provided with means capable of allowing the continuous adjustment of the opening angle of the working arm 10, within a wide range of values, for positioning and/or clamping work pieces, for welding operations and/or for other applications in the motor vehicle manufacturing field, or in other fields.

[0032] Consequently, according to a further feature of the invention, the apparatus is provided with sensing means 33 capable of continuously detecting, both the closed angular position of the working arm 10, indicated by reference B in Fig. 1, and all the angularly spaced-apart opening positions possible for the working arm 10, one of which has been indicated by reference A.

[0033] In the case shown, the sensing means for detecting the angular positions of the working arm 10 comprise, for example, a plurality of optical sensors 33' or of any other type, disposed side by side inside the box-shaped body 12, parallely to the longitudinal axis of the same body 12; the sensors 33' are selectively activated or actuated by a lug 34 laterally secured to the part 18B of the piston rod 18.

[0034] The sensors 33' are secured and connected to an electronic circuit card 35 programmed to allow a self-learning of the desired angular opening position, when the working arm 10 remains stationary for a few instants, as described in EP-A-1,623,795, introduced herein for reference.

[0035] The apparatus also comprises means for adjusting the opening angle of rotation of the working arm 10, which can be operated from the outside; according to the invention, the adjustment of the opening angle is obtained by simply screwing, to change and adjust the length of the rod 18 of the piston, in relation to the desired opening position of the working arm 10.

[0036] The means for adjusting the opening angle comprise a drive member 36 which can be manually operated to rotate the threaded element 18A by acting from the bottom of the actuator, with respect to the piston 26 and the threaded element 18B; the threaded element 18A can be screwed or unscrewed to change the axial extension of the entire rod 18. In this connection, the drive member 36 comprises a piston 36' rotatably supported in a hole 37 of the head 30 at the bottom end of the actuator 14; a shank 38 of the piston 36' ends with a hexagonal head 39 selectively engageable with and disengageable from a hexagonal hole 40 made in a rear-end extension 41 of the rod element 18A, onto which is secured a bush 42.

[0037] The hole 37 is of such dimensions as to allow the rotation and brief axial displacement of the drive member 36, so as to engage the hexagonal head 39 in the hexagonal hole 40; in this way the rod 18 of the actuator 14 can be lengthened and shortened, and its length finely and continuously adjusted, to make the working arm 10 rotate to the desired opening position.

[0038] Therefore, whenever it is required to adjust the opening position of the arm 10, an operator simply inserts a key into the hexagonal hole 36A of the piston 36', through a hole in the head 30, then pushes the piston 36' upwards to engage the hexagonal head 39 in the hole 40; subsequently, by means of the same key he rotates the piston 36' and consequently the threaded element 18A to adjust the length of the rod 18, changing the distance between the piston 26 and the hinge pin 17'. The box-shaped body 12, in correspondence with the axis 11 of rotation of the working arm 10, is provided with a graduated indication of the opening angle set by adjusting the length of the rod 18 of the actuator.

[0039] When the compressed air is fed into the actuator 14 through the aperture 28, the same air, through suitable passages, is automatically fed into the hole 37 causing the drive member 36, to shift backwards and disengaging it from the rod 18.

[0040] Lastly, the apparatus further comprises a pneumatic damping and braking device for the piston 26, as illustrated hereunder with reference to Fig. 4; the pneumatic damping and braking device are provided for damping and braking the piston 26 on the final portion of its return stroke, during the opening movement of the working arm 10.

[0041] In particular, the damping device comprises the bush 42 integral with the piston 26; the bush 42 has a slightly conical outer surface, of a diameter smaller than the internal diameter of an axial extension of the hole 37, to form an annular chamber 43 in communication with the compressed air inlet/discharge aperture 28. During the last portion of the return stroke of the piston 26, the bush 42 passes through an annular airtight seal 44 capable of performing a brief axial movement; in this way the compressed air that remains between the piston 26 and the head 30 is forced out along the branched off path or duct 45, comprising an adjustable throttling valve 46. The path 45 is branched off between the chamber 25 of the cylinder 24 and the annular chamber 43 of the damper. It should be pointed out that the seal 44 is able to shift slightly in an axial direction against a stop washer 47 to allow a passage of compressed air at the beginning of the working stroke, until the bush 42 has slipped off completely.

[0042] From what has been described and shown, it will be clear that a drive apparatus is provided for operating a working arm, by means of which it is possible to substantially continuously vary and adjust the angular opening position of the arm itself, within a wide range of values, by means of a mechanically simple, extremely reliable solution, capable of enabling the reduction of the overall dimensions of the apparatus itself.

[0043] Lastly, Fig. 1 shows a second possible solution of the means for stopping the arm 10 in the working position B, in place of or in combination with the stopping means 21; in fact, it is possible to provide a stop member 48, at the lower end of the rod element 18B, or otherwise secured, which penetrates completely into a seat 49 in the front head 29. In both cases the stroke of the piston 26 and the length of the cylinder 24 remain substantially unchanged and are not critical in that the arm 10 stops in the working position B anyway, regardless of the length of the rod 18.

[0044] Other modifications or variations may be made, to the toggle-lever drive device, the pneumatic actuator and/or the device for adjusting the length of the rod 18 and/or to the pneumatic damping device, without thereby deviating from the scope of the invention, as defined by the claims.

Claims

1. A drive apparatus for clamping a work piece and/or positioning a work piece or a tool, comprising:

a box-shaped body (12) having a longitudinal axis;

a working arm (10) rotatably supported by the box-shaped body (12), to rotate between a first angular opening position (A) and a second angular closing position (B) for clamping a work piece and/or positioning a work piece or tool;

a linear pneumatic actuator (14) secured at one end of the box-shaped body (12), said pneumatic actuator (14) comprising a single piston member (26) reciprocable in a piston chamber (25), said piston member (26) having an axially extensible rod (18) comprising a first threaded element (18A) connected to the piston member (26), and a second threaded element (18B) having a front end hingedly connected to a toggle-lever system (13) operatively connected to the working arm (10), said first threaded element (18A) being threadingly engageable with the second threaded element (18B) to selectively change the axial space between the piston member (26) and the hinged connection (17'); and

sensing means (33) for detecting opening positions of the working arm (10),

characterised in that the first threaded element (18A) is rotatably secured to the piston member (26) of the actuator (14), the second threaded element (18B) extending into the piston chamber (25) with a rear end axially spaced apart from the piston member (26);

externally operable rod-length adjusting means (36) being provided, said rod-length adjusting means comprising a drive member (36) rotatably supported at one end of the actuator (14), said drive member (36) being selectively engageable with and disengageable from the first threaded element (18A) to rotate the same first threaded element (18A) of the piston rod (18);

work-arm stop means (21; 48) being arranged

inside the box-shaped body (12) for stopping the working arm (10) in the closing position (B); and **in that** said sensing means (33) comprise a plurality of sensors (33') actuated by the piston rod (18), said sensor (33') being parallelly arranged to the longitudinal axis inside the box-shaped body (12) to detect the work arm (10) in a plurality of angularly spaced apart positions of the same working arm (10).

2. The apparatus according to claim 1, **characterised in that** the first threaded element (18A) engages in an internally threaded hole in the second element (18B) of the rod (18) of the piston (26).

3. The apparatus according to claim 1, **characterised in that** the stop means (21) are disposed inside the box-shaped body (12) enclosing the toggle-lever system (13) which connects the piston rod (18) to the working arm (10).

4. The apparatus according to claim 1, **characterised in that** the stop means (48) are secured to the piston rod (18), and **in that** a closing head (29) of the actuator (14) comprises a seat (49) for housing the stop means (48), in the closed position (B) of the working arm (10).

5. The apparatus according to claim 1, **characterised in that** said drive member (36) comprises a second piston (36') rotatably fitted and axially sliding in a hole (37) in a head (30) of the actuator (14), said piston (36') having a shank (38) shaped to removably engage with a hole (39) in the piston rod (18) of the actuator (14).

6. The apparatus according to claim 5, **characterised in that** the hole (37) for housing the drive member (36), is connected with an inlet/discharge aperture (28) for compressed air for the actuator (14).

7. The apparatus according to claim 1, **characterised in that** the drive member (36) is manually operatable from the outside of the linear actuator (14).

8. The apparatus according to claim 1, **characterised by** comprising pneumatic damping means (42, 44, 45, 46) for braking the movement of the piston (26) of the actuator (14) in the final portion of the return stroke towards the open position (A) of the working arm (10).

9. The apparatus according to claim 8, **characterised in that** said pneumatic damping means (42, 44, 45, 46) comprise a branched off duct (45), between the chamber (25) of the actuator (14) and an air inlet/outlet aperture (28), said branched off duct (45) comprising a throttle valve (46).

10. The apparatus according to claim 1, **characterised in that** said plurality of sensors (33') are connected to an electronic circuit (35) programmed for self-learning the opening position (A) of the working arm (10).

Fig. 1

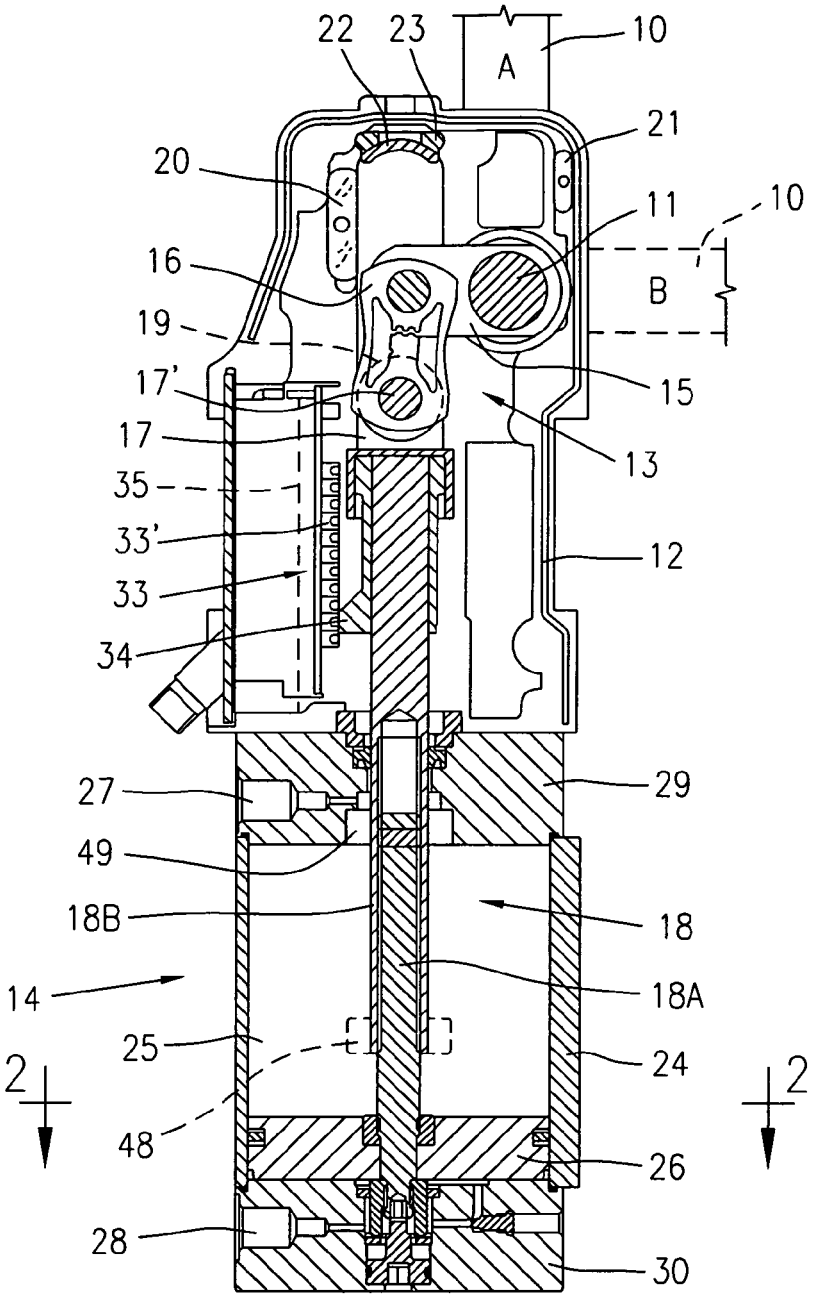

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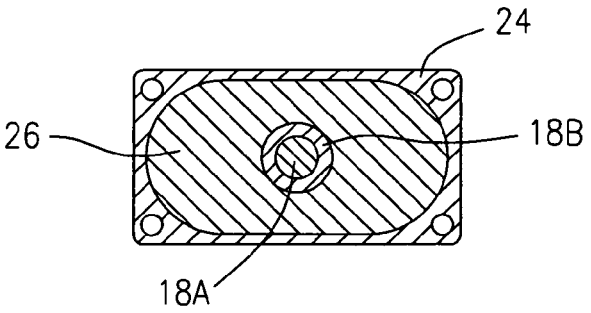
Fig. 2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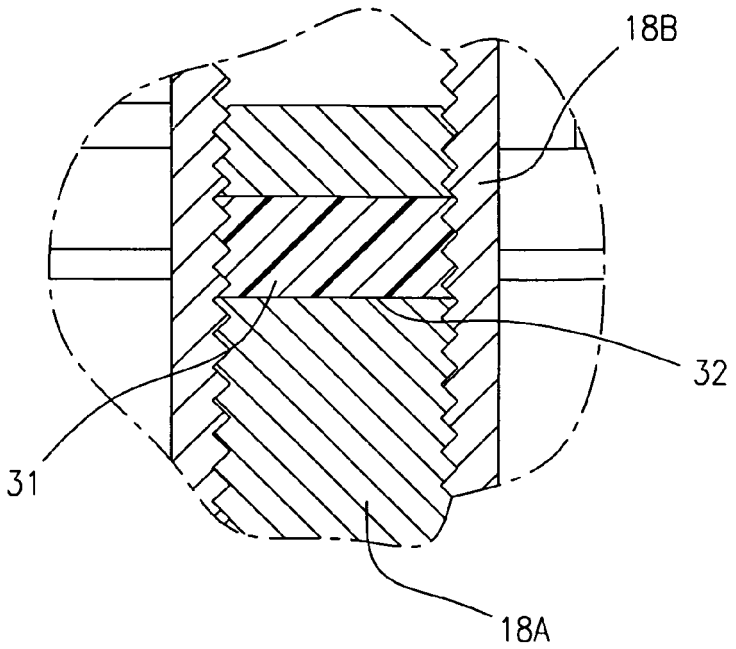
18A

Fig. 3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18A

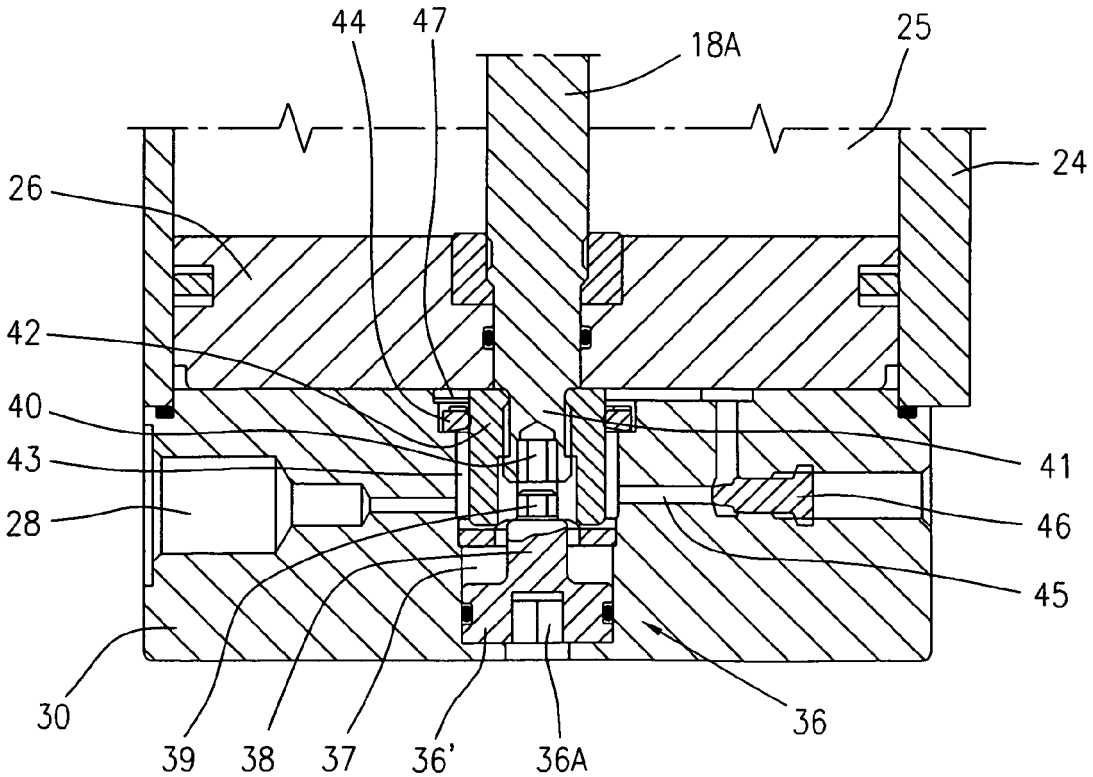
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Fig. 4

European Patent Office

EUROPEAN SEARCH REPORT

Application Number
EP 07 00 8203

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The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
The Hague	20 June 2007	Majerus, Hubert

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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EPO FORM 1503 03.82 (P04C01)

ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 07 00 8203

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
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