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(54) A METHOD AND A SYSTEM FOR CONTROLLING AN ACTUATOR OF A RAM OF A PRESS

(57) The method and the system for controlling a cylinder actuator (115) of a ram of a press comprises: a motor group (101) that actuates a pumping group (102); a ram that is hydraulically connected by a hydraulic system with the motor group (101) and/or pumping group (102) and that is movably actuated between a first stroke of approach to a piece to be worked, a second working stroke of the piece to be worked, and a third return stroke from a worked piece; an accumulator (105) being connected with a chamber (113) on the rod side of the cylinder actuator (115), a pressure reducer (108) to control the pressure inside the accumulator (105), in which the motor group (101) connected with the pumping group (102) controls the approach stroke and/or the working stroke and/or the return stroke.

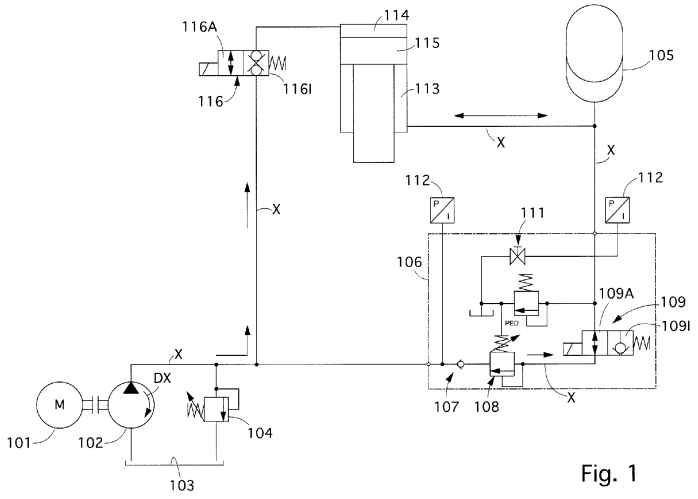

Fig. 1

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F15B 2211/30575; F15B 2211/31529;
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F15B 2211/40507; F15B 2211/41581;
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F15B 2211/5753; F15B 2211/625;
F15B 2211/6309; F15B 2211/6313;
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Description

Field of application

[0001] The invention relates to a method and a system for controlling an actuator of a ram of a press, used for working pieces to be worked, to make the working cycle and the structure of the press more economical.

State of the art

[0002] A known hydraulic circuit installed on a press to actuate its ram comprises a series of components that allow the ram, in order to perform workings of pieces such as punching or folding, to carry out a quick stroke of approach to the piece, followed by a slower extra-stroke to perform working, and a final return stroke in the rest position raised by the piece.

[0003] Typically, according to the known state of the art, presses are divided in two types, namely presses that have a ram having a considerable self-weight, which affects its general operation, and presses that have rams with a self-weight that is considered light and which scarcely affect the general operation.

[0004] In both types of presses, basically two types of circuits are used to move the ram.

[0005] In a first known construction scheme of the hydraulic circuit that actuates the ram, an asynchronous motor is provided, which actuates a constant-flow pump, which, in turn, feeds an accumulator acting as a tank of the pumped oil.

[0006] At the accumulator exit a servo-valve is arranged that, in turn, is hydraulically connected with the push chamber of the cylinder the piston of which actuates the ram.

[0007] The movement of the piston, in this case, is controlled by the servo-valve.

[0008] In a second known construction scheme of the hydraulic circuit that actuates the ram of the press, an asynchronous motor is provided that, however, in this case functions with a fixed number of revolutions and is connected with a variable-flow pump, which, in turn, feeds the push chamber of the cylinder the piston of which actuates the ram.

[0009] The movement of the piston of the cylinder, in this case, is controlled by the servo-valve mounted on the pump that controls the flow-rate and the working pressure.

[0010] For over a five-year period a new system has been adopted that provides the use of a servo-pump, composed of a brushless motor combined with a four-quadrant pump, normally with internal gears or with pistons, that, besides controlling the speed and the direction of the actuator that moves the ram, with the use of a measurement system determines its position and with the use of a pressure transducer can limit its load.

[0011] In this hydraulic system, the pumps used, either of the type with internal gears or of the type with axial pistons, are in both cases usually of the four-quadrant type.

[0012] In all cases cited, to reverse the direction of motion of the ram and to perform the workings requested, pumps must be able to reverse their direction of rotation as quickly as possible, typically in some milliseconds, to allow the performance of the working cycles of the pieces.

[0013] This state of the art has some drawbacks.

[0014] A drawback consists in the fact that pumps of the four-quadrant type, which are renownedly expensive and have a limited efficiency, are generally mounted in these hydraulic circuits, which, therefore, makes also the manufacturing and the maintenance of the presses that use them proportionally expensive.

[0015] A further drawback consists in the fact that with the use of known presses it is very difficult to establish some special working parameters exactly, such as, for instance, the verification and the possible successive correction of the folding angle of a piece during its working, i.e. it is very difficult to move the ram at a low speed with centesimal displacements in both directions.

Presentation of the invention

[0016] An object of the invention is to improve the known state of the art.

[0017] Another object of the invention is to provide a method and a system for controlling an actuator of a ram of a press that allows to reduce general manufacturing costs.

[0018] A further object of the invention is to achieve a method and a system for controlling an actuator of a ram of a press that has a structure that is simplified and, consequently, economical as compared to the state of the art.

[0019] According to an aspect of the invention, there is provided a method for controlling an actuator of a ram of a press in accordance with the features of claim 1.

[0020] According to another aspect of the invention, there is provided a system for controlling an actuator of a ram of a press in accordance with the features of claim 5.

[0021] Further aspects of the invention are indicated in the dependent claims.

[0022] The invention allows to achieve the following advantages:

- limiting the manufacturing costs of presses for working pieces to be worked;
- accurately performing and controlling special workings of the pieces to be worked, such as, for instance, a folding angle.

Brief description of the drawings

[0023] Further features and advantages of the invention will be clearer from the detailed description of a preferred, but not exclusive, form of embodiment of a method and a system for controlling an actuator of a ram of a

press, illustrated by way of a nonlimiting example in the hydraulic diagrams shown in the attached drawings, in which:

FIG. 1 is a view of a diagram of a hydraulic system according to the invention, in a configuration of a ram of a press provided with a self-weight that is not considerable, in a configuration of loading an accumulator inserted in the system;
FIG. 2 is the diagram of Figure 8 in a condition of stop of the ram to an upper dead center;
FIG. 3 is the diagram of Figure 8 in a condition of quick descent, of working and of maintenance of the action of the ram;
FIG. 4 is the diagram of Figure 8 in a condition of return of the ram toward the upper dead center.

Detailed description of preferred examples of embodiment.

[0024] With reference to Figures from 1 to 4, here below the components of a hydraulic circuit according to the invention are indicated, in a second possible form of embodiment, particularly suitable to be used for the operation of a press in which the ram has a self-weight that is not particularly considerable and that, therefore, is not able to affect its movements remarkably, in particular, but not only, in the phase of movement toward a piece to be worked.

101 = brushless motor;

102 = constant-flow pump;

103 = reservoir;

104 = maximum pressure valve;

105 = accumulator;

106 = feeding unit of the accumulator 105;

107 = unidirectional valve of 106;

108 = pressure reducer of 106;

109 = cartridge electro-valve of 106;

110 = PED safety valve of 105;

111 = cock/outlet electro-valve of 105;

112 = pressure transducers;

113 = cylinder chamber on the rod side;

114 = cylinder chamber on the head side;

115 = actuating cylinder of the ram;

116 = shut-off valve.

[0025] With reference to figure 1, a load condition of the accumulator 105 is noticed, in which the pump 102 is actuated by the motor 101 and rotates in an active rotation in the direction indicated by the arrow "DX".

[0026] In this condition the ram of the press is stationary and the oil under pressure, following the hydraulic line (x), reaches the accumulator 105, passing through the feeding unit 106 in which the electrovalve 109 is in the open position 109A.

[0027] The oil under pressure reaches also the chamber 113 on the rod side of the cylinder 115, which, however, remains stationary, since the shut-off valve 116 is positioned in the closed condition 1161, preventing drainage of oil from the chamber 114 on the head side of the cylinder 115.

[0028] When one of the pressure transducers 112 placed on the hydraulic line (x) detects that a programmed pressure value has been reached, at which value the pressure reducer 108 was set in advance, it interrupts the operation of the motor 101 and, consequently, of the pump 102.

[0029] With reference to Figure 2, a static condition of the ram is observed, because the cylinder 115 is kept at the UDC after the completion of the loading phase of the accumulator 105.

[0030] In this condition, the motor 101 stands still, just like the pump 102, and both are not subject to load.

[0031] The oil under pressure that is present in the chamber 113 and in the accumulator 105 from the previous phase of filling keeps the cylinder 115 at the UDC flowing in the hydraulic line indicated with (o).

[0032] In this condition, the press punch is raised in relation to the die and an operator can position a piece to be worked under the ram, between the punch and the die, or can carry out other maintenance operations.

[0033] With reference to Figure 3, a condition is observed that can be alternatively of quick descent of the ram, or a working condition, or a condition of so-called maintenance, this latter being a condition in which the ram remains stationary in a position of work completed and waits, for instance, for the yield of the material with which a piece is manufactured during the working phase, or for the cooling down of a piece just manufactured.

[0034] In detail, it is noticed that the shut-off valve 116 is switched to the open position 116A, connecting the pump 102 that rotates in an active rotation "DX", actuated by the motor 101, delivering oil under pressure to the chamber 114 following the arrows F2.

[0035] It must be observed that in this embodiment of the hydraulic circuit according to the invention, the self-weight of the ram is substantially uninfluential with respect to the movement of descent of the cylinder 115, which is moved, therefore, by the push of oil under pressure that reaches the chamber 114 on the push side of

the cylinder 115 through the line (x): the movement of the cylinder 115 is opposed in the phase of descent by the pressure of the oil that is present in the chamber 113 on the rod side and that in this condition flows out towards the accumulator 105 along the hydraulic line (o), according to the direction of the arrow F4.

[0036] The descent of the actuating cylinder 115 is controlled by a known signaling system of its position and, when it reaches the lower limit position that corresponds to the final working position of a piece to be worked, the condition of maintenance mentioned before is activated, in which the actuating cylinder 115 is kept stationary until the material in which the piece to be worked is manufactured has stabilized or cooled down: this is the case, for instance, of a folding work of a sheet metal piece that, after the active phase of proper folding, requires a waiting phase, to allow the folded sheet metal to stabilize its own condition of internal stress caused by folding, or to cool the formed piece, for instance in case of forming pieces manufactured in glass.

[0037] In the condition illustrated in Figure 3, the movement downwards of the cylinder 115 is controlled by the difference of the pressures of the oil volumes that are present in the chambers 114 and 113, this latter in connection with the accumulator 105 that in this condition behaves like a compressible hydraulic spring.

[0038] With reference to Figure 4, a condition of return of the cylinder 115 toward the upper dead center (UDC) is observed after the completion of a working phase.

[0039] In this condition, the shut-off valve 116 is kept in the open configuration 116A connecting, through the hydraulic line (#), the chamber 114 with the reservoir 103, through the pump 102.

[0040] The latter is brought in passive counter-rotation indicated by the arrow "SX" by the flow of oil that flows out from the chamber 114.

[0041] The counter-rotation "SX" is contrary to the active rotation "DX" and the counter-rotation speed is controlled by the motor 101 that, in practice, acts as a brake for the rotation of the pump 102 that becomes a control element of the outflow of oil through the hydraulic line (#) and, consequently, of the speed of reascent of the cylinder 115 toward the UDC.

[0042] In this condition, the accumulator 105 feeds oil under pressure into the chamber 113 on the rod side through the line (o) according to the arrow F5, providing the necessary push for the return of the cylinder 115, and the unidirectional valve 107 prevents oil under pressure that flows out from the accumulator 105 from flowing directly towards the reservoir 103, i.e. by-passing the cylinder 115.

[0043] The pressure reducer 108 allows both to change the pressure inside the accumulator 105 and to discharge a small quantity of oil through its drainage duct.

[0044] When the cylinder 115 moves down, the oil that is present in the chamber 113 is pushed into the accumulator 105, causing a pressure increase inside the latter, previously established by the pressure reducer 108.

[0045] This pressure increase causes a drainage of small quantities of oil from the pressure reducer 108 (of the order of 2-4 liters per minute, considering that the drainage activates in the cycle, only in the phase of descent of the cylinder) that is restored when the cylinder 115 carries out a reascent stroke.

[0046] During this phase, pressure inside the accumulator 105 decreases down to a value lower than the one determined by the pressure reducer 108, and the oil present in the inside is constantly refilled by a supply of additional fresh oil.

[0047] It must be noticed that, according to the invention, the use of the accumulator 105 with the function of hydraulic spring is also possible in a press in which the self-weight of the ram (or of the rammer) is considerable.

[0048] In this case, the presence of the accumulator 105, which performs the function of a hydraulic spring having a variable force, since it is arranged to contain oil with an adjustable pressure, on the one side allows for the use of two-quadrant pumps and on the other side improves the repeatability at the UDC in the presses having rams with a considerable weight.

[0049] In a folding press, the action of the accumulator 105, besides improving the positioning accuracy of the ram/rammer, allows to control the displacement speeds thereof and with the counter-rotation of the brushless motor and of the pump, allows the rammer to move micrometrically in both directions, i.e. to float, a condition that, with the use of four-quadrant pumps, is difficult to be achieved.

[0050] In a folding press, the presence of the accumulator 105 allows both to obtain an improvement of the final position, and to control the speed of the ram causing it to move micrometrically in both directions.

[0051] In practice, it has been ascertained that the invention achieves the objectives that it set itself.

[0052] The invention as it was conceived is susceptible to modifications and variants, all of them falling within the inventive idea.

[0053] Further to that, all the details can be replaced by other elements that are technically equivalent.

[0054] In the practical execution, the materials used as well as the forms and dimensions can be any, according to the requirements, without for this departing from the scope of protection of the following claims.

Claims

1. A control method for controlling a cylinder actuator (115) comprising a chamber (113) on the rod side of the cylinder actuator (115) and a chamber (114) on the head side of the cylinder actuator (115), the cylinder actuator (115) being configured for actuating a ram of a press, the control method **characterized by** comprising:

   - providing an accumulator (105) in connection

with said chamber (113) on the rod side of the cylinder actuator (115);
- actuating a motor group (101) with which a pumping group (102) consisting of a 2-quadrant pump that is directly fluidly connected to said chamber (114) on the head side of said cylinder actuator (115) by a fluid-dynamic circuit for a feeding fluid and having an active rotation (DX) and a passive counter-rotation (SX) is associated;
- reciprocating said cylinder actuator (115) between an active working stroke during said active rotation (DX) and a return stroke during said counter-rotation (SX), wherein the movement of the cylinder actuator (115) in the phase of descent is opposed by the pressure in the chamber (113) on the rod side of the cylinder actuator (115) that is fluidly connected to said accumulator (105);
- controlling by said motor group and pumping group (101, 102) at least one of said active stroke and/or return stroke during at least one of said active rotation (DX) and/or said counter-rotation (SX).

2. detecting by means of a pressure transducer (112) the reaching of a programmed pressure value to which a pressure reducer (108) is set, so as to control the pressure inside the accumulator (105). The method as claimed in claim 1, wherein said controlling comprises controlling an active working speed of said active stroke and/or a return speed of said return stroke.

3. The method as claimed in claim 1, wherein said motor group comprises a brushless motor (101).

4. The method as claimed in claim 1, wherein said active stroke comprises alternatively punching, folding, molding pieces to be worked.

5. The method as claimed in claim 1, wherein the downward movement of the said cylinder actuator (115) is controlled by the difference of the pressures of the feeding fluid volumes that are present in said chambers (114, 113).

6. A system for controlling a cylinder actuator (115) comprising a chamber (113) on the rod side of the cylinder actuator (115) and a chamber (114) on the head side of the cylinder actuator (115), the cylinder actuator (115) being configured for actuating a ram of a press by reciprocating said ram at least in an active working stroke or in a passive return stroke, the system being **characterized by** comprising:

- a motor group (101);
- a pumping group (102) consisting of a 2-quadrant pump that is directly connected with said chamber (114) on the head side of the cylinder actuator (115), associated with said motor group (101) and designed to pump a feeding fluid to said a chamber (114) on the head of the cylinder actuator (115);
- an accumulator (105) fluidly in connection with said chamber (113) on the rod side of the cylinder actuator (115) and designed to oppose in the phase of descent of said cylinder actuator (115);
- a connecting and conveying fluid-dynamic circuit which connects said pumping group (102) with said cylinder actuator (115) and with said accumulator (105) through hydraulic lines (x, o, #) and conveys a feeding fluid between them;
- control means of at least said active working stroke or of said passive return stroke consisting in said motor group (101) associated with said pumping group (102);
- a feeding unit (106) interposed between said motor group (101), said pumping group (102) and said accumulator (105), said feeding unit comprising a pressure reducer to set a programmed pressure value, so as to control the pressure inside the accumulator (105);
- a pressure transducer (112) for detecting when said programmed pressure value is reached.

7. The system as claimed in claim 6, wherein said motor group comprises a brushless motor (101).

8. The system as claimed in claim 6 or 7, wherein said feeding unit (106) comprises a unidirectional valve (107) for preventing feeding fluid under pressure from flowing out from the accumulator (105) directly towards the reservoir (103), so as to avoid the bypassing of said cylinder actuator (115).

9. The system as claimed in any of the claims 6-8, wherein said feeding unit (106) comprises an electrovalve (109) for selectively allowing or prevent the feeding fluid from reaching said accumulator (105).

10. The system as claimed in any of the claims 6-9, comprising a shut-off valve (116) connected to the chamber (114) on the head side of the cylinder actuator (115).

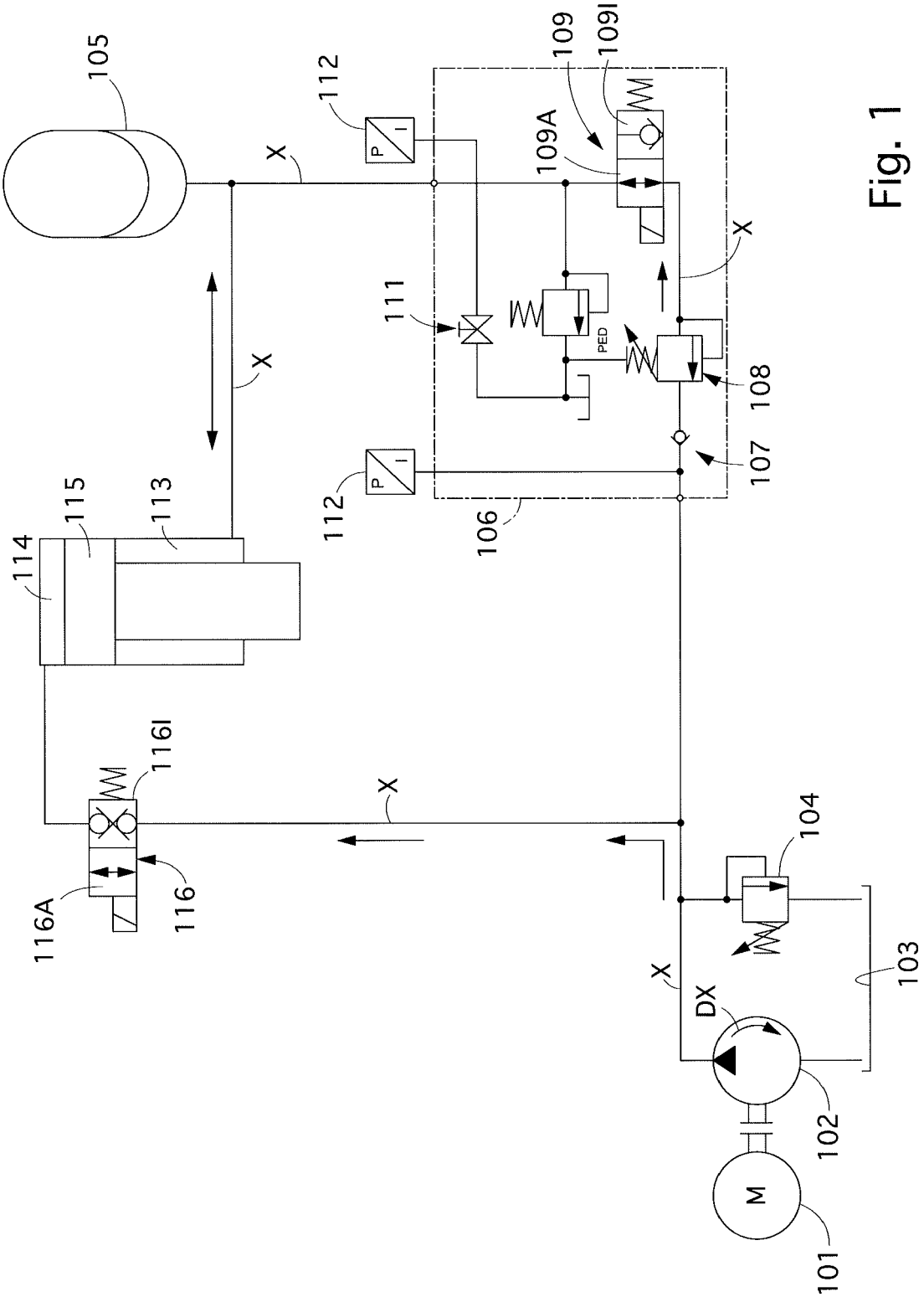
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Fig. 1

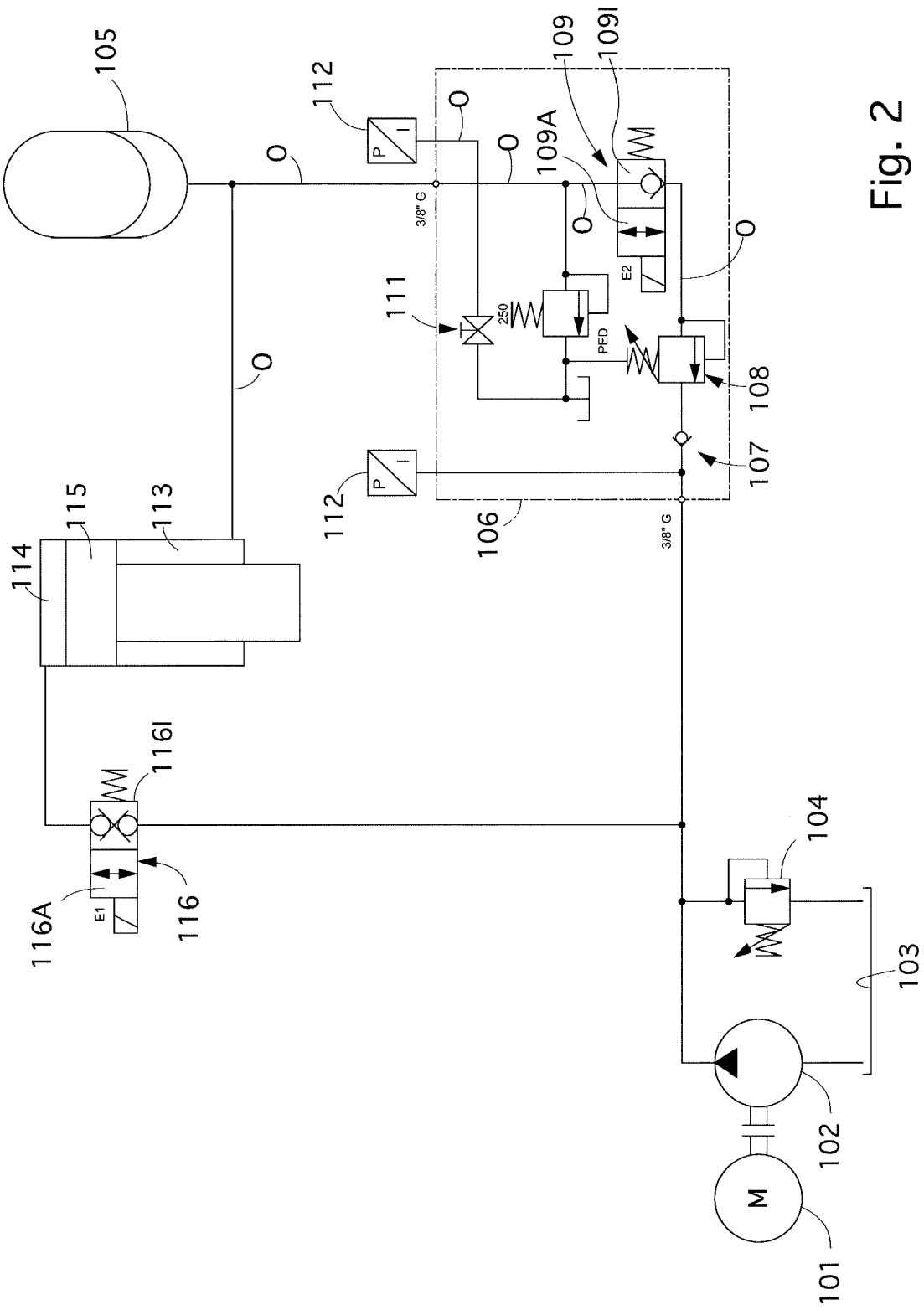
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Fig. 2

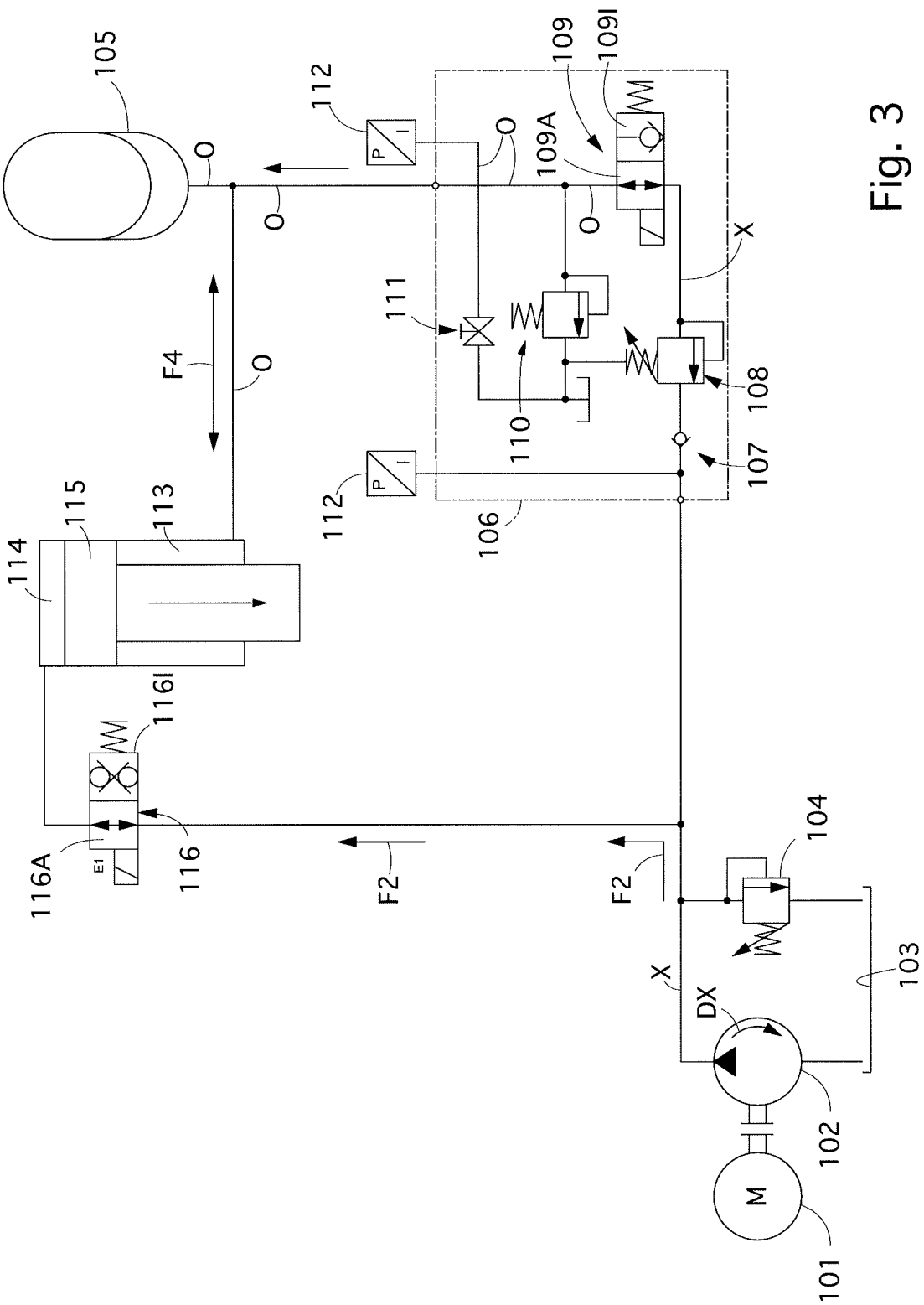
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Fig. 3

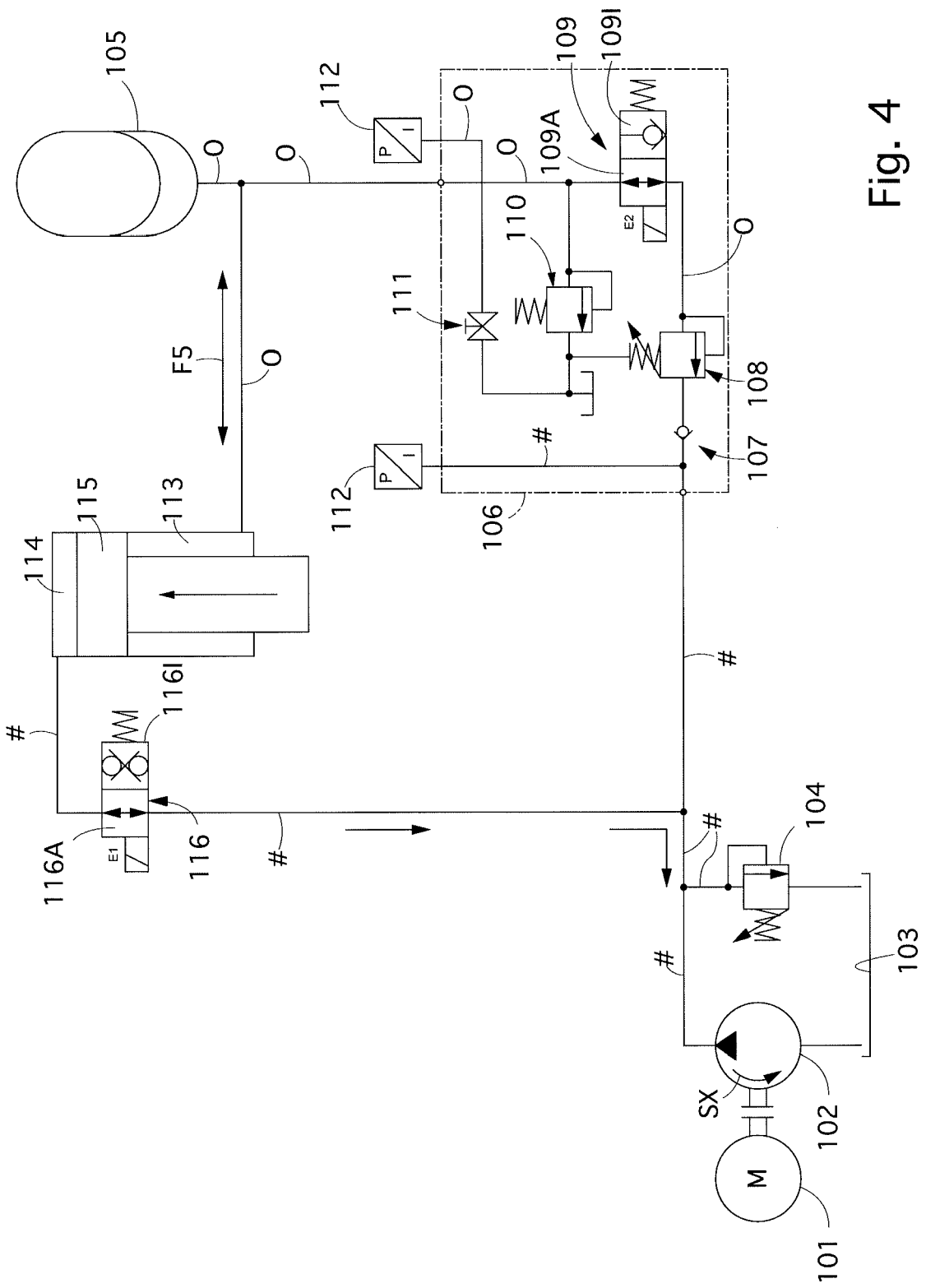
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Fig. 4

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EUROPEAN SEARCH REPORT

Application Number
EP 22 15 6619

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
Y	US 2015/083002 A1 (GRAF MATTHIAS [DE] ET AL) 26 March 2015 (2015-03-26) * paragraph [0039] - paragraph [0078]; claims; figures *	1-10	INV. B30B15/16 B30B15/20 B30B15/18 F15B1/02
Y	US 2012/216746 A1 (SCHNEIDER GERD [DE]) 30 August 2012 (2012-08-30) * paragraph [0026] - paragraph [0027]; claims; figures * * paragraph [0062] *	1-10	
A	EP 1 279 488 A1 (AMADA CO LTD [JP]) 29 January 2003 (2003-01-29) * claims; figures *	1,6	
A	WO 2013/167610 A1 (DIEFFENBACHER GMBH MASCHINEN [DE]) 14 November 2013 (2013-11-14) * claims; figures *	1,6	
A	US 2006/070378 A1 (GEIGER DAVID [US]) 6 April 2006 (2006-04-06) * claims; figures *	1,6	TECHNICAL FIELDS SEARCHED (IPC) B30B F15B F15D B29C
A	DE 10 2011 116964 A1 (BOSCH GMBH ROBERT [DE]) 16 May 2012 (2012-05-16) * figures *	1-10	

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
The Hague	5 July 2022	Baradat, Jean-Luc

CATEGORY OF CITED DOCUMENTS

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05-07-2022

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 2015083002 A1	26-03-2015	CN 104284772 A	14-01-2015
		DE 102012104125 A1	14-11-2013
		EP 2846994 A1	18-03-2015
		JP 2015522419 A	06-08-2015
		KR 20150006476 A	16-01-2015
		RU 2014149771 A	10-07-2016
		US 2015083002 A1	26-03-2015
		WO 2013167630 A1	14-11-2013
US 2012216746 A1	30-08-2012	CN 102596425 A	18-07-2012
		DE 102009051316 A1	05-05-2011
		EP 2493627 A1	05-09-2012
		JP 5744889 B2	08-07-2015
		JP 2013509496 A	14-03-2013
		KR 20120086295 A	02-08-2012
		RU 2012121920 A	10-12-2013
		UA 104342 C2	27-01-2014
		US 2012216746 A1	30-08-2012
		WO 2011050876 A1	05-05-2011
		ZA 201202765 B	27-12-2012
EP 1279488 A1	29-01-2003	EP 1279488 A1	29-01-2003
		TW 514566 B	21-12-2002
		US 2003159599 A1	28-08-2003
		WO 0166340 A1	13-09-2001
WO 2013167610 A1	14-11-2013	DE 102012104124 A1	14-11-2013
		EP 2846993 A1	18-03-2015
		JP 2015521109 A	27-07-2015
		KR 20150007342 A	20-01-2015
		RU 2014149769 A	10-07-2016
		US 2015158262 A1	11-06-2015
		WO 2013167610 A1	14-11-2013
US 2006070378 A1	06-04-2006	US 2006070378 A1	06-04-2006
		WO 2006039262 A2	13-04-2006
DE 102011116964 A1	16-05-2012	CN 103201093 A	10-07-2013
		DE 102011116964 A1	16-05-2012
		EP 2637852 A1	18-09-2013
		ES 2622496 T3	06-07-2017
		TW 201244920 A	16-11-2012
		WO 2012062416 A1	18-05-2012

EPO FORM P0459

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