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

(11) **EP 3 427 939 A1**

(12) **EUROPEAN PATENT APPLICATION**

(43) Date of publication:
16.01.2019 Bulletin 2019/03

(51) Int Cl.:
B30B 15/16 *(2006.01)* ***B30B 15/26*** *(2006.01)*
F15B 1/02 *(2006.01)* ***F15B 1/027*** *(2006.01)*

(21) Application number: **18178339.0**

(22) Date of filing: **18.06.2018**

(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
Designated Validation States:
KH MA MD TN

(30) Priority: **20.06.2017 IT 201700068317**

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(54) **AUTOMATIC CONTROL SYSTEM FOR CHARGING PRESSURE ACCUMULATORS, AND THE CONTROL METHOD THEREOF, FOR HYDRAULIC PRESS**

(57) An automatic control system (1) for charging piston pressure accumulators for a press comprises a pre-charge station (20) provided with a plurality of gas cylinders (21) connected to each other, a plurality of use stations (40) each having at least one piston accumulator (41) designed to be charged with a gas pre-charge, and a pre-charge line (6) connecting the pre-charge station (20) with each use station (40). The system (1) is characterized in that a pump station (30) is inserted between the pre-charge station (20) and the use station (40) and is provided with a piston accumulator (31) actuated by a pump (32), from which it receives pressure energy, and adapted to manage the pressure connection between the pre-charge station (20) and each use station (40).

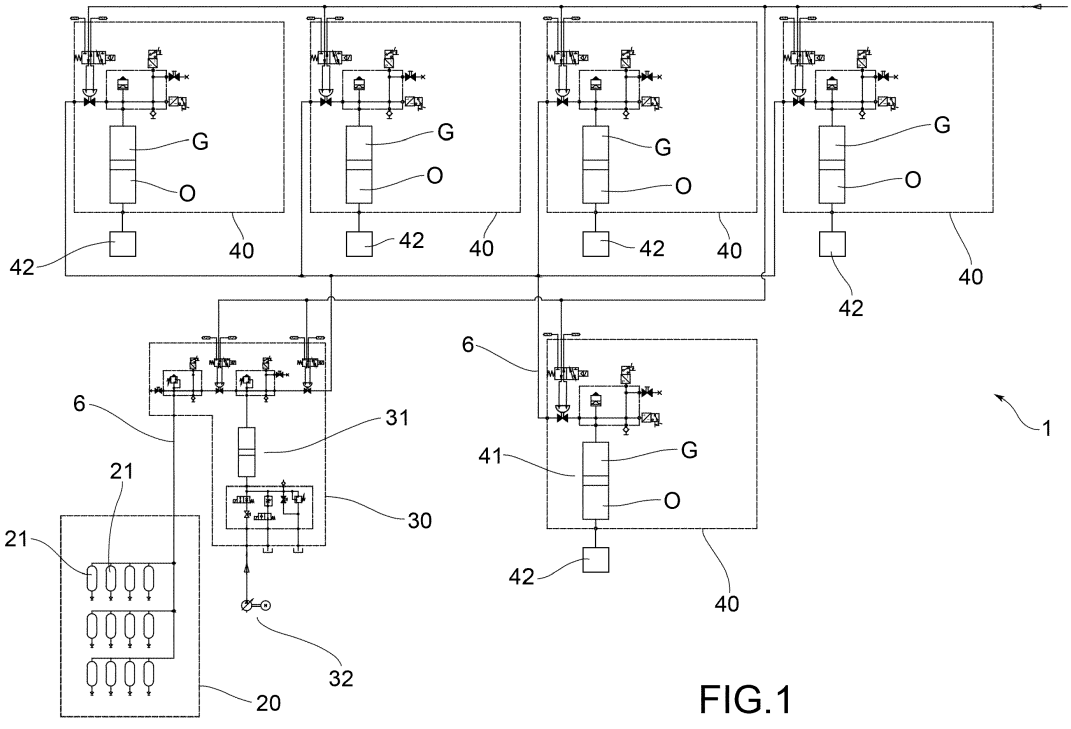

FIG.1

EP 3 427 939 A1

Description

[0001] The object of the present invention is an automatic control system for charging pressure accumulators of a hydraulic press, for example for the pressing of non-ferrous metals. In particular, the object of the invention is a system for the automatic variation of the gas pre-charge in piston accumulators.

[0002] As is known, piston accumulators belong to the group of pressure accumulators and are used to exchange energy using the hydraulic system to which they are connected. The piston accumulator is thus used to accumulate pressure energy to be supplied to a use unit, for example to the punching cylinders for the slide of a press.

[0003] The piston accumulator consists of a cylinder closed at both ends, wherein a sealed piston slides. The piston divides the inside of the cylinder into two chambers, one filled with gas (generally nitrogen) under suitable pressure and the other filled with the fluid of the hydraulic system to which it is connected (usually oil).

[0004] The gas pressure must be chosen according to the working conditions of the accumulator and represents the pre-charge pressure.

[0005] Managing the gas pre-charge is an essential and delicate aspect. To control and/or pre-charge and/or adjust the pre-charge pressure of the piston accumulator, a nitrogen cylinder and a suitable apparatus are used. If the pre-charge pressure is lower than the value required for the use unit, it is necessary to connect an inflation tube to the apparatus on one side and to the nitrogen cylinder on the other, slowly introducing the nitrogen into the accumulator until reaching the established pressure. Obviously, this operation must be performed for each accumulator, and for each accumulator it is necessary to have a nitrogen cylinder at a pressure corresponding to the desired pressure so that the nitrogen may flow into the accumulator. The operations of managing the gas pre-charge are therefore complex, expensive and time-consuming.

[0006] The object of the present invention is to resolve the problems of the prior art while taking into account the requirements of the industry.

[0007] This object is achieved by an automatic control system for charging piston pressure accumulators, wherein the variation of the gas pre-charge is obtained by an automatic piloting.

[0008] This object is achieved by an automatic control system for charging piston pressure accumulators according to claim 1, as well as by a relative automatic control method for charging piston pressure accumulators according to claim 7 or 9. The dependent claims describe preferred embodiments of the invention.

[0009] Further features and advantages of the invention will become clearer in the light of the detailed description of a preferred but not exclusive embodiment, illustrated by way of non-limiting example with the aid of the accompanying figures, wherein:

- figure 1 shows the complete diagram of an automatic control system for charging accumulators according to the present invention, in an example of embodiment comprising a pre-charge station 20, a pump station 30 and a plurality of use stations 40, each comprising a piston accumulator connected to a respective use unit;
- figure 2 shows in detail the pre-charge station 20 and the pump station 30 of figure 1;
- figure 3 shows in detail a use station 40 of figure 1.

[0010] With reference to the aforementioned figure 1, a system for automatically charging piston pressure accumulators, in accordance with the present invention, is collectively indicated at 1.

[0011] The system 1 is designed to automatically vary the gas pre-charge (for example nitrogen) of the accumulators by means of a hydraulic piloting.

[0012] The system 1 comprises:

- a pre-charge station 20, which constitutes an accumulation of gas to be used as a pre-charge for a plurality of accumulators;
- a plurality of use stations 40, each comprising at least one piston accumulator 41 intended to be charged with a gas pre-charge;
- a pre-charge line 6 connecting the pre-charge station 20 to each use station 40;
- a pump station 30, connected to the pre-charge line 6, suitable for managing the pressure connection between the pre-charge station 20 and each use station 40.

[0013] The pre-charge station 20 comprises a plurality of gas cylinders 21, for example nitrogen, connected together. The set of such gas cylinders 21 constitutes a gas battery, or a gas accumulation to be used as pre-charge for a plurality of accumulators.

[0014] The pump station 30 comprises at least one piston accumulator 31 operated by a pump 32, preferably hydraulic, which feeds the entire system 1 for automatically controlling the charging of piston pressure accumulators.

[0015] The piston accumulator 31 consists of a cylinder closed at both ends, wherein a sealed piston 310 slides. The piston 310 divides the inside of the cylinder into two chambers, one filled with gas (generally nitrogen) under suitable pressure and the other filled with the fluid of the hydraulic system to which it is connected (usually oil). The piston accumulator 31 thus comprises a gas side G and an oil side 0.

[0016] The piston accumulator 31 is connected, on the oil side 0, to the pump 32, by means of a pair of valves suitable for managing the pressure charging and discharging steps. In particular, there is a valve 331 for charging the oil and a valve 332 for discharging the oil.

[0017] The piston accumulator 31 is connected, on the gas side G, to the pre-charge line 6, by means of a pair

of valves suitable for managing the pressure charging and discharging steps. In particular, there is a valve 333 for charging the nitrogen and a valve 334 for discharging the nitrogen.

[0018] The pump station 30 further comprises, both on the gas side and on the oil side, safety valves 335 for managing the overpressure of the system 1.

[0019] The pump station 30 also comprises, connected to the gas side, digital pressure switches 336 for checking the pre-charge pressure.

[0020] Each use unit 40 comprises at least one piston accumulator 41.

[0021] The piston accumulator 41, exactly like the piston accumulator 31, consists of a cylinder closed at both ends, wherein a sealed piston 310 slides. Also the piston accumulator 41 thus comprises a gas side G and an oil side 0.

[0022] The piston accumulator 41 is connected, on the oil side 0, to a use unit 42, for example a punching cylinder for the slide of a press, to which it supplies pressure energy.

[0023] The piston accumulator 41 is connected, on the gas side G, to the pre-charge line 6, by means of a valve 43 suitable for managing the pressure charging and discharging steps, i.e. the charging and discharging with nitrogen.

[0024] The use station 40 further comprises, connected to the gas side, a rupture disc 45 for managing the overpressure of the system 1.

[0025] The use station 40 also comprises, connected to the gas side, a digital pressure switch 46 for checking the pre-charge pressure.

[0026] The use station 40 further comprises, connected to the gas side, a thermostat 44 for controlling the temperature of the gas (nitrogen) so that, during the discharge of the accumulator 41, such temperature never falls below a well-defined limit threshold.

[0027] The automatic control method for charging the accumulators 41 in the system 1 will be described hereinafter.

[0028] Description of the operation for increasing the pressure in the accumulator 41 of the use station 40, i. e. to adjust the nitrogen pre-charge pressure which must flow from the pre-charge station 20 to the use station 40.

[0029] The charge valve 333 of the pump station 30 (with the discharge valve 334 closed) is commanded to open to put such station 30 in communication with the pre-charge station 20 and to allow the nitrogen to charge the accumulator 31 until an equilibrium of the pressures is reached. At this point, the accumulator 31 is filled to its maximum volume on the gas side G.

[0030] Along the pre-charge line 6, the charge valve 333 is commanded to close to disconnect the pre-charge station 20, and the discharge valve 334, together with the valve 43 of the desired use station 40, is commanded to open to put the pump station 30 in communication with the desired accumulator 41.

[0031] On the oil side of the accumulator 31 of the pump station 30, the charge valve 331 (with discharge valve 332 closed) is then commanded to open to put the accumulator 31 in communication with the pump 32. The pump 32 is programmed to the desired use pressure. The pump 32 then pressurizes the oil of the accumulator 31 which pushes (through the piston 310 within the accumulator 31) the gas (nitrogen) under pressure to the accumulator 41 of the use station 40.

[0032] Upon reaching the desired pressure in the accumulator 41 of the use station 40, the discharge valve 334 of the pump station 30 and the valve 43 of the use station 40 are commanded to close to disconnect such station 40 from the pre-charge line 6.

[0033] In the pump station 30, on the oil side of the accumulator 31, the charge valve 331 is commanded to close and the discharge valve 332 is commanded to open to discharge the residual oil present in the accumulator 31.

[0034] The operation must be repeated for each of the use stations 40 present in the system 1.

[0035] Description of the operation for reducing the pressure in the accumulator 41 of the use station 40, i. e. to adjust the pressure of the nitrogen pre-charge which must flow from the use station 40 to the pre-charge station 20.

[0036] First of all, the discharge valve 334 of the pump station 30 and of the valve 43 of the use station 40 are commanded to open to connect such station 40 to the pre-charge line 6 and allow the nitrogen to discharge from the accumulator 41 into the accumulator 31.

[0037] Upon reaching the desired pressure in the accumulator 41 of the use station 40, the discharge valve 334 of the pump station 30 and the valve 43 of the use station 40 are commanded to close to disconnect such station 40 from the pre-charge line 6.

[0038] Along the pre-charge line 6, the charge valve 333 is commanded to open to connect the pump station 30 with the pre-charge station 20.

[0039] On the oil side of the accumulator 31 of the pump station 30, the charge valve 331 (with discharge valve 332 closed) is then commanded to open to put the accumulator 31 in communication with the pump 32. The pump 32 is programmed to the desired pressure. The pump 32 then pressurizes the oil of the accumulator 31, which pushes (through the piston 310 inside the accumulator 31) the pressurized gas (nitrogen) into the cylinders 21 of the pre-charge station 20.

[0040] Along the pre-charge line 6, the charge valve 333 is commanded to close to disconnect the pump station 30 from the pre-charge station 20.

[0041] In the pump station 30, on the oil side of the accumulator 31, the charge valve 331 is commanded to close, and the discharge valve 332 is commanded to open to discharge the residual oil present in the accumulator 31.

[0042] The operation must be repeated for each of the use stations 40 present in the system 1.

[0043] Thus in summary, in the control system 1 ac-

cording to the present invention, a single pre-charge station 20 is provided, dedicated to a plurality of use stations 40. Moreover, a pump station 30 is interposed between the pre-charge station 20 and the use stations 40 for the automatic piloting, i.e. control, of the pre-charge pressure between the pre-charge station 20 and the use stations 40. Furthermore, the pump station 30 also comprises an accumulator 31 connected to the pre-charge line and commanded by a pump 32 (for example, hydraulic).

[0044] Innovatively, the automatic control system 1 for charging piston pressure accumulators according to the present invention, and the control method thereof allow the gas pre-charge of each individual accumulator of the use station to be varied by an automatic piloting.

[0045] Advantageously, therefore, the management operation of the gas pre-charge is managed in common for all the accumulators of the system 1 through a single pre-charge station 20 comprising a plurality of nitrogen cylinders 21. Moreover, the pressure corresponding to the desired pressure (or use pressure) for each accumulator 41 of the individual use station is managed automatically by the pump station 30 and controlled by the pump 32. The operations to manage the gas pre-charge are therefore simplified, with a consequent reduction in intervention times and costs.

[0046] It is clear that one skilled in the art may make modifications to the above-described system and control method thereof, all contained within the scope of protection as defined by the following claims.

Claims

1. Automatic control system (1) for filling piston pressure accumulators for a press, comprising:

   - a pre-charge station (20) comprising a plurality of gas cylinders (21), for example nitrogen, connected together;
   - a plurality of use stations (40), each comprising at least one piston accumulator (41) intended to be charged with a pre-charge of gas;
   - a pre-charge line (6) connecting the pre-charge station (20) to each use station (40);

   characterized in that a pump station (30), connected to the pre-charge line (6), is inserted between the pre-charge station (20) and the use station (40) and is provided with a piston accumulator (31) actuated by a pump (32) from which it receives pressure energy, adapted to handle the pressure connection between the pre-charge station (20) and each use station (40) .

2. Automatic control system (1) according to claim 1, wherein the accumulator (31) of the pump station (30) comprises an oil side (0) and a gas side (G) and is connected:

   - on the oil side (0), to the pump (32) by means of a valve (331) to charge the oil and a valve (332) to discharge the oil
   - on the gas side (G), to the pre-charge line (6) by means of a valve (333) to charge the nitrogen and a valve (334) to discharge the nitrogen.

3. Automatic control system (1) according to claim 1 or 2, wherein the accumulator (41) of the use station (40) comprises an oil side (0) and a gas side (G) and is connected:

   - on the oil side (0) to a use unit (42) to which it provides pressure energy.
   - on the gas side (G), to the pre-charge line (6) by means of a valve (43) adapted to handle the charging and discharging of the nitrogen.

4. Automatic control system (1) according to any one of the preceding claims, wherein the pump station (30) and/or the use station (40) comprises at least one safety valve (335,45) for managing overpressure, and/or at least one digital pressure switch (336,46) for controlling the pre-charge pressure.

5. Automatic control system (1) according to any one of the preceding claims, wherein the piston accumulator (31,41) consists of a cylinder, closed at both ends, wherein runs a sealed piston (310) which divides the cylinder into two chambers, one filled with nitrogen and the other with oil, and/or a thermostat (44) for controlling the gas temperature.

6. Automatic control system (1) according to any one of the preceding claims, wherein the pump (32) is a hydraulic pump.

7. Automatic control method for charging the accumulators (41) of the system (1) according to any one of the preceding claims, comprising the steps of:

   - increasing the pressure in the accumulator (41) of the use station (40) through the following steps:

     -- opening a gas charge valve (333) of the pump station (30) to put such station (30) in communication with the pre-charge station (20) and allowing the gas to charge the accumulator (31) until an equilibrium of the pressures is reached;
     -- closing the gas charge valve (333) to disconnect the pre-charge station (20), and opening a gas discharge valve (334) of the pump station (30) together with a gas valve (43) of the use station (40) to put the pump station (30) in communication with the accumulator (41) of the use station (40);

-- opening an oil charge valve (331) of the pump station (30) to put the accumulator (31) in communication with the pump (32) which pushes the gas under pressure to the accumulator (41) of the use station (40) until the desired pressure is reached;
-- closing the gas charge valve (334) of the pump station (30) and the gas valve (43) of the use station (40) to disconnect the station (40) from the pre-charge line (6).

8. Control method according to claim 7, comprising the final step of:

-- closing the oil charge valve (331) and opening the oil discharge valve (332) of the pump station (30) to discharge the residual oil present in the accumulator (31).

9. Automatic control method for charging the accumulators (41) of the system (1) according to any one of the preceding claims, comprising the steps of:

- reducing the pressure in the accumulator (41) of the use station (40) through the following steps:

-- opening a gas discharge valve (334) of the pump station (30) and a gas valve (43) of the use station (40) to discharge the nitrogen from the accumulator (41) into the accumulator (31) until the desired pressure is reached;
-- closing the discharge valve (334) of the pump station (30) and the valve (43) of the use station (40) to disconnect such station (40) from the pre-charge line (6);
-- opening a gas charge valve (333) for connecting the pump station (30) to the pre-charge station (20);
-- opening an oil charge valve (331) and closing the discharge valve (332) of the pump station to put the accumulator (31) in communication with the pump (32) which pushes the gas under pressure into the cylinders (21) of the pre-charge station (20) until the desired pressure is reached;

10. Control method according to claim 9, comprising the final step of:

-- closing the oil charge valve (331) and opening the oil discharge valve (332) of the pump station (30) to discharge the residual oil present in the accumulator (31).

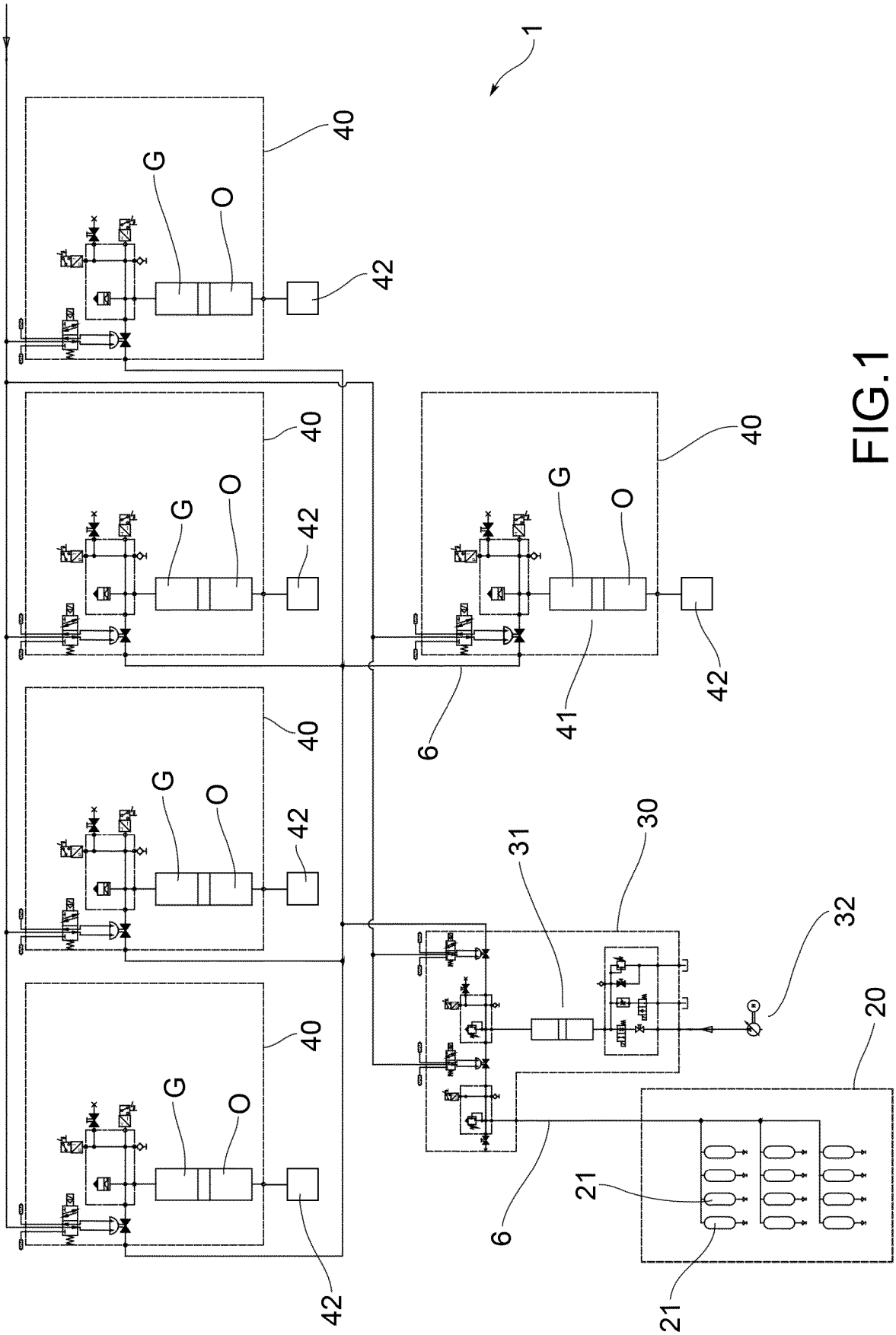

FIG.1

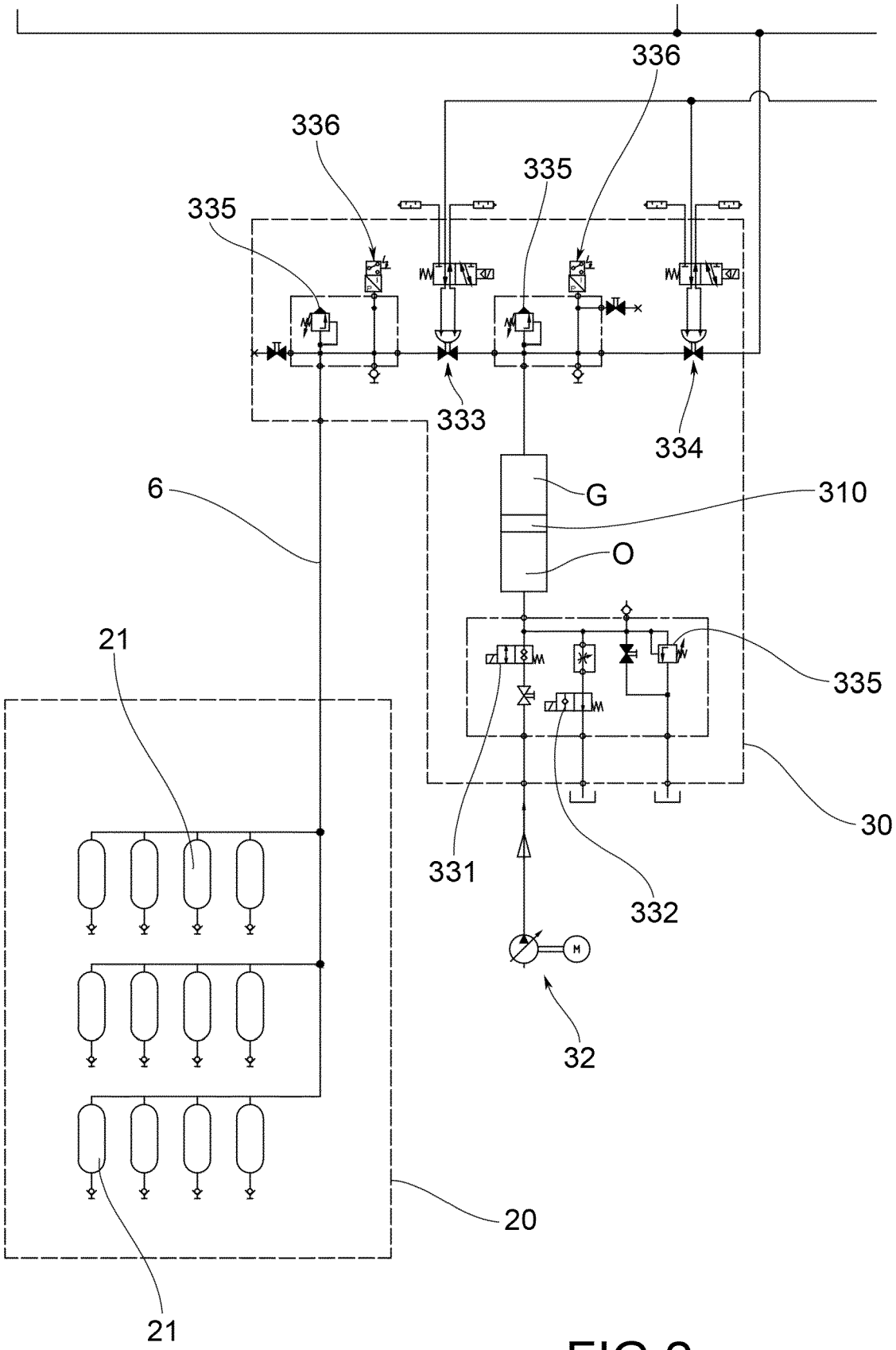

FIG.2

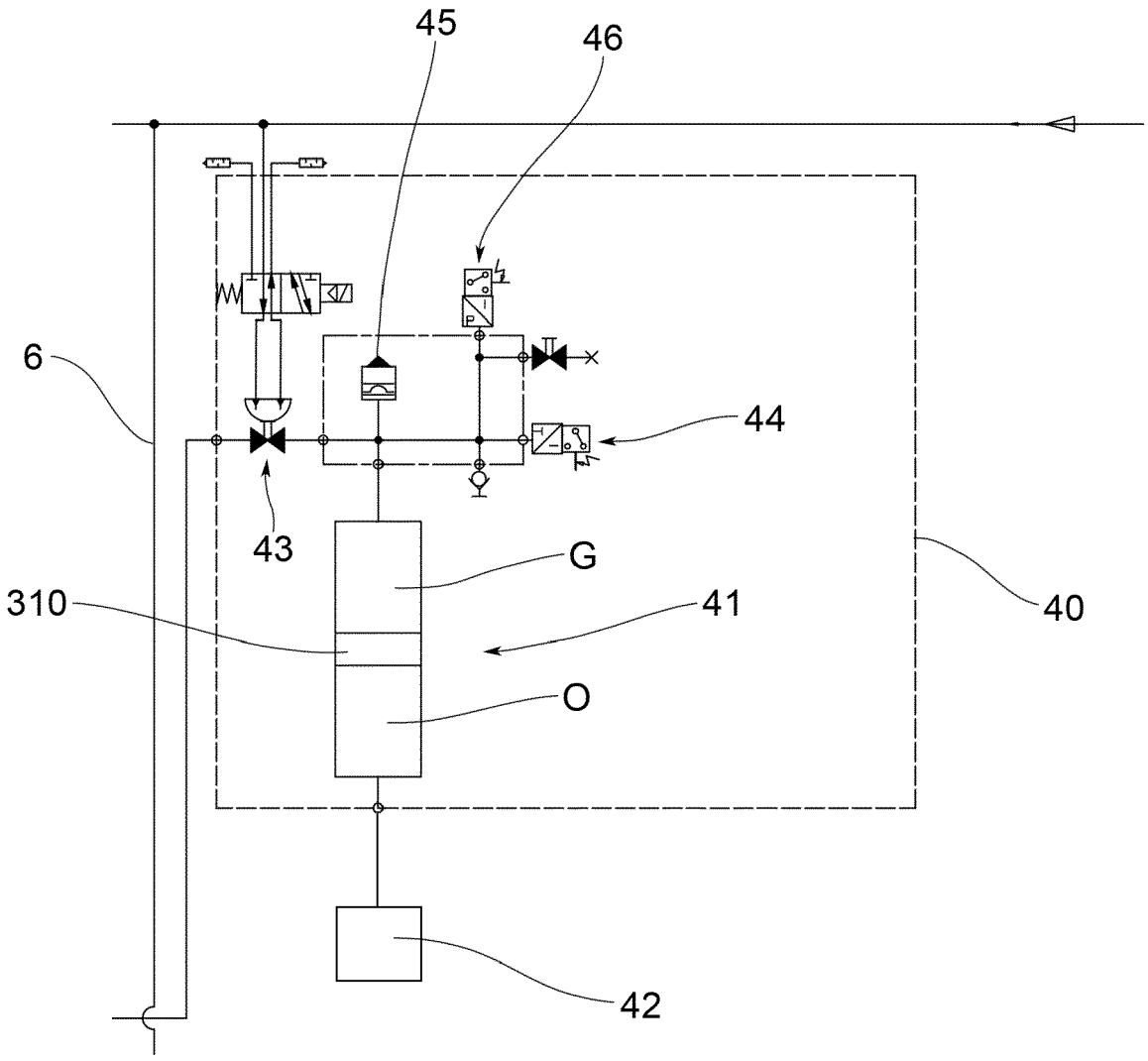

FIG.3

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EUROPEAN SEARCH REPORT

Application Number
EP 18 17 8339

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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	29 November 2018	Labre, Arnaud

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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