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(54) **HYDRAULIC VALVE DEVICE WITH MULTIPLE WORKING SECTIONS WITH PUMP CONTROL SYSTEM**

HYDRAULISCHE VENTILVORRICHTUNG MIT MEHRFACHEN ARBEITSABSCHNITTEN UND EINEM PUMPENSTEUERUNGSSYSTEM

DISPOSITIF DE SOUPAPE HYDRAULIQUE AVEC PLUSIEURS SECTIONS DE TRAVAIL ET UNE SYSTEME DE COMMANDE DE POMPE

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EP 3 390 842 B1

Description

SCOPE OF THE INVENTION

[0001] The present invention relates to the field of hydraulic valve devices with open circuit and multiple working elements or sections designed to control a pump.

[0002] Particularly, with the present valve device it is possible to control:

- In a first embodiment, a pump of variable displacement type with negative control system.
- In a second embodiment, a load sensing pump.

[0003] It is noted that the invention applies to hydraulic distributors.

PRIOR ART

[0004] In general, in the conventional working machines provided with an open-center hydraulic circuit it is possible to control the pump thereof.

[0005] In the case of variable displacement pump, the hydraulic pressure taken upstream of an orifice placed at the end of the bypass line, also called carry-over, is sent to the pump regulator. In particular, the control is such that, with decreasing pressure upstream of the orifice, the flow rate sent by the variable displacement pump increases. Therefore, it is said that it is a negative control circuit.

[0006] An example of prior art circuit is disclosed in US 2014/318116 referring to a hydraulic control device including pressure compensators that respectively increase and decrease flow rate of the oil flowing in accordance with specific pressure conditions.

[0007] Generally speaking, upon start up, the pressure acting on the regulator is null, whereby the pump tends to go to the maximum flow rate. However, increasing the flow rate increases the load losses through the orifice of the pressure signal control system, additionally comprising also a relief valve; it follows that:

- the pressure acting on the pump regulator increases, and
- the flow rate sent by the pump decreases, up to reach a balance point in which the load losses through the orifice of a given flow rate correspond to that control pressure on the pump PA regulator that generates that given flow rate.

[0008] In general, these systems also provide that the pump still generates a minimum flow and the balance between flow rate and control pressure of the pump regulator is as in the accompanying figure 4.

[0009] By operating only one spool, the passage through the bypass line LC narrows, whereby the pressure at the entry side at the beginning of the bypass line increases due to the increase of the load losses. At the same time, the connection between the load line and the utilities opens.

[0010] If the pressure at the utility is higher than the pressure generated at the entry side by the load losses through the bypass line, the entire flow rate will still continue to be bled through the bypass line, the load losses through the orifice remain unchanged and so does the flow rate sent by the pump.

[0011] By continuing to increase the stroke of the actuated spool, the load losses through the bypass line continue to increase until the pressure in the entry side exceeds the pressure of the load at the utility, with the result that part of the flow rate flows towards the utility itself, reducing the flow rate through the bypass line and in particular through the orifice: the control pressure of the pump regulator is thus reduced, with consequent increase of the flow rate. This new flow rate value will increase both the one to the utility and that to the bypass line until it reaches a new balance in which, however, the flow rate through the orifice will be lowered and so the flow rate sent by the pump is increased.

[0012] Consequently, the flow rate to the utility at a certain stroke of the relative spool depends on the load, if the load increases, the flow rate to the utility decreases and that through the orifice increases, with a consequent reduction of the flow rate sent, up to reach a new balance point in which the flow rate to the utility and that sent will have decreased while the flow rate through the orifice will have increased.

[0013] Since the flow rate, at a certain stroke, depends on the loads, it is not possible, even in single drives, to set a maximum flow rate at the utility that is not the maximum pump flow rate. Therefore, normally, the bypass line is closed, the flow rate through the choke is therefore zeroed like the load losses through the choke and the pump switches to the maximum displacement.

[0014] By actuating now also a second spool, the bypass line is further narrowed resulting in a reduction of the flow rate through the bypass line itself and through choke 2, with consequent decrease of the control signal to the pump and increase of the flow rate from the delivery to the utilities. The flow rate is divided between the two utilities on the basis of the reciprocal loads and as these loads vary, the division among the driven utilities varies and so does the sum of the single flow rates.

[0015] A first object of the present invention is to provide a valve device which allows eliminating some limits of the control system of a variable displacement, negative control or LS pump within a simple, rational and cost-effective solution.

[0016] These and other objects are achieved with the features of the invention described in the independent claim 1. The dependent claims describe preferred and/or particularly advantageous aspects of the invention.

[0017] In particular, a first aspect of the invention is to provide a valve device comprising a pressure regulator on the bypass line adapted to keep the pressure drop constant only along the bypass line through the elements

of the device.

[0018] With this solution:

- in the case of drives of the single spools of the single elements, the flow rate to the utility is independent of the load, i.e. a function only of the spool stroke; by this possibility, it is possible to set the maximum flow rate to the relative utility, in the case of multiple drives of the spools of the respective elements, the sum of the flow rates is independent of the loads, the subdivision among the single utilities remaining dependent on the loads.

BRIEF DESCRIPTION OF THE FIGURES

[0019] This and other features will be more apparent from the following description given purely by way of non-limiting example in the accompanying drawings.

- Figure 1: shows the standard circuit diagram of a valve device for controlling a pump, and precisely a negative control pump; the diagram description is substantially already indicated in the prior art.
- Figure 2: shows the circuit diagram of the pump control device, object of the invention, when the pump is of the variable displacement and negative control type.
- Figure 3: shows the circuit diagram of the pump control device, object of the invention, when the pump is of the variable displacement load sensing type.
- Figure 4: shows the adjustment curve of the displacement as a function of the control pressure of a variable displacement pump with negative control system.
- Figure 5: illustrates a further embodiment of the circuit diagram of the pump control device, subject of the invention, when the pump is of the type of variable displacement load sensing type.

DESCRIPTION OF THE PRIOR ART

[0020] With reference to figure 1, it shows an example of prior art, in particular a negative control variable displacement pump the displacement of which is determined by the control pressure N.

[0021] The control pressure N is given by the flow rate load losses through the fixed choke 2.

[0022] As said, a feature of the control negative pump is that the displacement (and thus the flow rate supplied) increases with decreasing control pressure PN and vice versa.

[0023] In detail, and with reference to the figure, the following definitions are used:

- QP, the flow rate delivered by the pump,
- QC, the flow rate which crosses the by-pass LC through all the spools in series and crosses the fixed choke 2,
- QU, the flow rate that goes to the utilities passing through the load line 4,
- PP, the pressure on the pump supply,
- PU, the pressure to the utility and in 4, where 4 indicates the load line, the line connecting the pump to the utilities passing through the spools in parallel. It is closed in central position and has the maximum opening at the end of the stroke.
- PN, the control pressure of the pump taken on line LC after all the elements and upstream of choke 2
- LC, the bypass line through the spools of the elements in series and the fixed choke 2, the passage has the maximum opening when the spool is in central position and closes at the end of the stroke.

[0024] As said, a feature of the control negative pump is that the displacement (and thus the flow rate supplied) increases with decreasing control pressure PN and vice versa.

[0025] In the figure it is seen that in central position of the spools LC is open while the connection between the load line 4 and the utilities is closed. Then, QP=QC. This flow rate goes into the tank through the by-pass line LC and choke 2.

[0026] Upon start up, the flow rate QP=QC is null, whereby PN, which is the load loss of the QC through choke 2, is low, but then the displacement tends to increase and therefore, QP=QC tend to increase. But as QP=QC increase, the load losses through 2 increase as well and thereby the PN increases, which opposes the increase of the displacement up to reach a balance between PN and QP=QC

[0027] Operating the spool opens the connection between the load line 4 and the utilities. At the same time, the passage through the by-pass LC through the operated spool is reduced. Therefore, the pressure PP which is equal to the PC increases, since the load losses of the flow rate through the LC increase. However, if now the pressure in PP is lower than the pressure PU required to move the cylinder, QU remains null, but then the whole flow rate QP=QC still goes to bleed through choke 2, but then the load losses through 2 remain unchanged, and then PN remains unchanged, whereby also the flow rate QP=QC remains unchanged.

[0028] Since QU is still virtually null, QP=QC still cause the same control PN through 2. The only difference is that PP=PC has increased but without causing changes.

[0029] By further operating the spool, the passage of by-pass LC is even more reduced. Therefore, pressure PP=PC increases further, since the load losses through LC increase. If now the pressure in PP is higher than the pressure PU required to move the cylinder, QU is no longer null, but then QC=QP-QU is reduced, whereby the load losses through choke 2 decrease, but then PN decreases and then the QP flow rate increases. Part of this increase is added to QU and part to QC until a new balance point is reached.

[0030] In practice, a balance point is reached in which

the QP generated by the PN is such that the load losses of the QC through the LC and choke 2 is equal to the PU generated by the load (the load losses with respect to the load PU are ignored for simplicity). Where QP has increased while QC has decreased and the difference is QU.

[0031] Now, keeping the same position of the spool, let's assume that PU increases. PC, which are the load losses of QC through LC and choke 2, is on the other hand initially unchanged. There is no more balance and part of the QU is combined with QC, which increases. But then, the load losses through choke 2 increase, whereby PN increases but then PP drops, until a new balance point is reached.

[0032] The new balance point must still have PU=PC. Since PU has increased, PC will also have to increase but to have a higher PC without having moved the spool, QC must be higher but then PN is higher and then QP is lower. But QP=QU+QC, if as said QP has decreased and QC has increased in the new balance point QU has decreased.

DESCRIPTION OF THE INVENTION

CONTROL OF A NEGATIVE CONTROL PUMP

[0033] With reference to figure 2, it shows a circuit of the type comprising a variable displacement pump according to the present invention.

[0034] In this case, the type of variable displacement pump, indicated with PA, is "negative control"; the delivery is connected in P1 to the entry side FE.

[0035] One or more elements E1...En (in the case 2 elements E1 and E2) of the crossing type that allows connecting the PA pump and the tank to the various utilities through the uses (A1, B1, A2, B2).

[0036] A bleeding side FS keeps the flow rates from the bypass line LC separate from those coming from the return of the utilities and from the bleeds of the valves and connects them both to tank T through two separate lines.

[0037] In the circuit of the valve device in figure 2 there is at least one delivery line P1 connected to the variable displacement pump for negative control systems PA, which feeds the side FE and the crossing elements E1 and E2, downstream at high pressure; it is noted that the number of elements varies depending on the number of utilities to connect.

[0038] A bypass or crossing line is also provided, indicated with LC, connecting the delivery P1 to the tank: however, contrary to what happens in standard crossing valve distributors, where they all are connected so as to come out of a single fitting, in the present invention the bypass line, and thus the flow rate flowing into line LC is kept separate with respect to the lines of the return flow rates of utilities and valves, which equally go to tank T but with two separate fittings, that is:

- independent fitting C, connecting the bypass line LC to tank T,
- low pressure bleed channel 6, into which the bleeds of valves and utilities flow.

[0039] In any case, both the bypass line LC and the return of the utilities and the valve bleeds are connected to tank T.

[0040] The following are also present:

- Spools C1, C2...Cn of elements E1, E2,...En which intercept, among the others, said bypass line LC; the passage in LC is open when spools C1, C2.. Cn are in central position, it is reduced with increasing stroke up to close or reach the maximum choke at the end of the stroke,
- A load line 4 connecting the delivery line P1 to the utilities with the closed passage in central position and open at the end of the stroke, also with possibility of intermediate choked positions,
- A choke 2 placed on the bypass line LC and after all sections E1, E2..En,
- A by-pass valve 3 of the choke 2 itself.
- A connection line N or control signal, for direct or indirect connection to the control signal line of pump PA.

[0041] Bearing in mind the configuration just described and with reference to the figures, it is noted that in the entry side FE, the delivery of pump PA (in this example, it is noted that it is negative control) is divided into two channels:

- The bypass line LC which, with spools C1 and C2 in central position, crosses all the elements E1, E2 and then connects to the tank through connection C,
- The load line 4 which, with spools C1... Cn in central position, is a closed line.

[0042] The presence of a pressure regulator valve 5 arranged only on the bypass line LC. Valve 5 in this example is calibrated at 30 bar.

[0043] Upon start up, the pressure acting on the regulator is null, whereby pump PA tends to go to the maximum flow rate.

[0044] Increasing the flow rate increases the load losses through orifice 2, and thus the pressure acting on the pump PA regulator, decreasing the flow rate sent by the pump PA, up to reach a balance point in which the load losses through orifice 2 correspond to that control pressure on the pump PA regulator that generates that given flow rate.

[0045] This flow rate creates a certain load loss along the bypass line LC through the elements (E1, E2), thus generating a defined pressure just downstream of the regulator 5.

[0046] The regulator 5 is calibrated just above such a pressure value.

[0047] This system also provides that the pump still generates a minimum flow and the balance between flow rate and control pressure of the pump regulator is as in figure 4.

[0048] In other words, for the variable displacement pump, the displacement is determined by the control pressure N. The control pressure N is given by the flow rate load losses through the fixed choke 2. The inclusion of the regulator 5 imposes a constant pressure PC.

[0049] In the central position of the spools, LC is open while connection 4 with U is closed. Then, QP=QC. This flow rate goes into the tank passing through LC and choke 2.

[0050] Upon start up, the flow rate QP=QC is null, whereby PN, which is the load loss of the QC through choke 2, is low, but then the displacement tends to increase and therefore, QP=QC tend to increase. But as QP=QC increase, the load losses through 2 increase as well and thereby the PN increases, which opposes the increase of the displacement up to reach a balance between PN and QP=QC

[0051] By operating the spool, this must perform a stroke section before the connection between P and U opens through the load line 4. In that stroke section, the passage through the LC already begins to narrow. Now, in the system object of the invention, the passage through the LC is configured so that upon opening of the connection between P and U, pressure PC is equal to the calibration of the regulator 5. Where PC is generated by the load losses of QP=QC through the LC and choke 2.

ACTUATION OF A SPOOL

[0052] Operating a spool, such as that indicated with C1, opens the connection between the load line 4 and the relative utility.

[0053] The passage through the bypass line LC narrows, whereby the pressure in said bypass line LC after the regulator 5 increases due to the increase of the load losses.

[0054] In fact, since PC is generated by the load loss of QC through the LC, PC increases; hence, it follows that it exceeds the calibration of the regulator 5, which consequently begins to narrow the passage between P and LC. In doing so, PP pressure rises but it is still lower than PU, then QP=QC continues to go in T passing through the LC and choke 2; the regulator continues to choke until PP exceeds PU and so, part of QP becomes QU and the QC drops, but then PC drops until PC becomes again equal to the calibration of the regulator 5.

[0055] The regulator 5 is in fact configured so as to keep the pressure constant at its calibration value, then it intervenes by reducing the flow rate (only in the bypass line LC) at that value, whereby the load losses are equal to the calibration of the regulator 5.

[0056] Doing so decreases the flow rate through choke 2, and thus the pressure of the pump control signal, which will then send more flow rate.

[0057] However, the regulator 5 prevents this additional flow rate from flowing in the bypass line LC.

[0058] Said additional flow rate only flows towards the actuated utility, i.e. through the load line 4 and to the utility.

[0059] Consequently, the flow rate to the utility is independent of the load but only a function of the spool stroke, unlike the prior art of the circuits with negative control systems.

[0060] It is noted that the flow rate QU is generated independently of the load but only as a function of the stroke. Meanwhile, since QC has decreased, the load loss through choke 2 has decreased and thus, having PN decreased and QP increased, this increase, as already described, goes all in QU.

[0061] If the spool is further operated, the LC chokes more and the PC increases, but then the regulator 5 intervenes and brings QC down up to return PC equal to the calibration, but if QC decreases, PN decreases and then QP increases, to the benefit of the QU.

[0062] In more detail, by continuing to further operate spool C1, the load losses through the bypass line LC and thus the pressure immediately downstream of the regulator 5 tends to increase, making regulator 5 itself intervene; the latter re-establishes its calibration by further reducing the flow rate in the bypass line LC, which in turn reduces the load losses through choke 2, and thus the pressure of the control signal of the pump PA regulator, with consequent increase of the flow rate sent by the pump.

[0063] A flow rate that goes entirely to the utility.

[0064] It follows from the above that the flow rate to the utilities is independent of the load but only a function of the stroke. It follows that, in the single drives, it is also possible to set a maximum flow rate to the utility that is not the maximum flow rate of the pump, unlike what the prior art negative control does.

[0065] Now, the same position of the spool is kept and let's assume that PU increases: PP increases as a consequence, which tends to increase QC. But its increase increases the load losses through the by-pass line LC, and thus the PC which therefore exceeds the calibration of the regulator 5. Consequently, this intervenes by choking the passage between P and LC, thereby generating a reduction of the QC to bring it in exactly to the same initial value which corresponds to that PC value that is equal to the calibration of regulator 5. It is noted that since the QC has not changed, the load losses through 2 have not changed and so PN and QP have not changed. Since the QP and the QC have not changed, the QU has remained constant since QP=QC+QU.

[0066] The above demonstrates that the flow rate at the utility depends only on the stroke of the spool and is independent of the load, in contrast to what happens in the known negative control system.

[0067] Since in the single movement the flow rate at the utility is independent of the load, with an appropriate shape of the spool it is possible to set a maximum flow

rate at the end of the stroke different from that of the pump. This is not possible in the known negative control.

[0068] Again as said, the actuation of multiple elements simultaneously leads to the generation of a total flow rate along the load line 4 which is always independent of the load. However, the division of this total flow rate, which as said is independent of the load, among the various utilities depends on the relative pressures between the utilities. The fact that at least the total flow rate is independent of the load makes the control of the concurrent movements by the operator easier, unlike the known negative control that does not have this advantage.

ACTUATION OF MULTIPLE SPOOLS

[0069] Let's assume that also a second spool, C2, is actuated.

[0070] The bypass line LC narrows further resulting, in the order:

- increase of the load losses,
- increase of pressure just downstream of regulator 5,
- triggering of regulator 5 so as to return the pressure to the calibration value of the regulator,
- reduction of the flow rate in the bypass line LC,
- reduction of the load losses through choke 2,
- reduction of the control pressure of pump PA,
- increase of the flow rate sent to pump PA.

[0071] The division of the flow rate between the two utilities depends on the reciprocal loads but, unlike the prior art, the total flow supplied by the pump PA is independent of the utilities.

[0072] Having set, with the regulator valve 5, a fixed pressure of the bypass line LC before the first element and being the pressure in the tank fixed and considered null, a fixed pressure drop is set by said regulator 5 between the beginning of the LC before the first section and the tank.

[0073] Supposing to be in a central position, through the various spools C1, C2...Cn there will be suitable passage areas A plus choke 2, since

$$Q = A \times Cf \times \sqrt{\frac{\Delta P}{\rho}}$$

[0074] The presence of regulator 5 only on the bypass line LC sets the pressure stage ΔP; in addition, the passage area through the bypass line LC is known and defined: the value of a given flow rate Q is thus obtained from the formula, which crosses all the line LC and orifice 2 (the latter placed on the same line, downstream).

[0075] Since the control signal N is taken after all the elements E1..En but before the fixed choke 2, it follows that the pressure at that point is given by the load losses of the determined flow rate Q through choke 2 (considering the pressure in tank T as null).

[0076] When all the spools C1..Cn are in a central position, said predetermined flow rate Q must be equal to the minimum one of pump PA.

[0077] This condition occurs with the control pressure equal to or slightly greater than a predetermined pressure P, a function of the setting of pump PA. Choke 2 must therefore be such that at the minimum pump flow rate, it generates a load loss equal to or slightly greater than that of the calibration at which the pump sends the minimum flow rate, with reference to the pump adjustment curve.

CONTROL OF A LOAD SENSING PUMP

[0078] The circuit of the valve device shown is, as said, adapted to also control a load sensing pump.

[0079] In the example described above, the control feeds the control signal of the negative control pump and generates a flow rate inversely proportional to the control pressure (in turn inversely proportional to the stroke of the spools).

[0080] In the embodiment variant that contemplates the control of a load sensing pump PA and with particular reference to figure 3, which shows the circuit operation, said control signal N now closes a suitable choke, i.e. a proportional opening tray 7, a tray that is placed along the load line 4.

[0081] In figure 5 it is illustrated another possible embodiment of the invention which comprises a load sensing pump PA; instead of the choke 7 is observed the presence of another choke 17 of a proportional opening drawer, in this case said choke 17 is located along the delivery line, upstream of the junction that separates LC and the load line 4; the connection line N now acts on the relative drawer so that:

- In its central position is partly open and configured to allow the flow strictly required to have a reduced pressure on the bypass line (LC)
- In work's configuration, namely piloting configuration, allows the passage of the entire flow capacity.

[0082] In this situation, the passage through the choke imposed by tray 7, 17 opens in a manner inversely proportional to the pressure of control P, and thus proportional to the stroke of spools C1, C2... Cn.

[0083] An LS signal downstream of said choke of tray 7, 17 arrives at the LS PA pump, so the latter sends a flow rate proportional to the opening of the choke, in turn inversely proportional to the control pressure which is in turn inversely proportional to the stroke of spools C1, C2, ...Cn.

[0084] In summary, with the described valve device, through a connection line N it is possible to directly control a variable displacement pump PA with negative control

system, or with the valve device described, through a control N and a proportional tray on the load line 4 it is possible to indirectly control a variable displacement load sensing pump PA. In the latter case, the control signal is configured for opening in a manner inversely proportional the choke of the tray 7, 17 while a signal (LS) from the load line 4, downstream said choke, arrives to the pump.

[0085] For both solutions, the valve device has a regulator valve 5 only on the bypass line LC and upstream of the first element E1. In the single drive, it makes the flow rate to the utility independent of the load and allows setting a maximum flow rate at the end of the stroke; in multiple drives, it ensures that the sum of the required flow rates is independent of the loads.

[0086] The regulator 5 is configured so as to impose a constant pressure drop along the single bypass line LC and through the elements E1, En.

[0087] The bypass line LC is configured to be connected to tank T through a fitting C, independent of the fitting into which the return flow rates of utilities and valves flow.

Claims

1. Modular directional valve device, fitted with one or more elements (E1, E2,.. En), said valve device being suitable for controlling a variable displacement pump (PA), said one or more elements (E1...En) being of the crossing type allowing connection of the variable displacement pump (PA) and of a tank to various utilities through respective uses (A1, B1, A2, B2); said valve device comprising at least one delivery line (P1) and said valve device being arranged for the connection to the pump (PA) through said at least one delivery line (P1) and further comprising at least one load line (4) for connecting said at least one delivery line (P1) to the utilities, said at least one load line (4) passing through respective spool of said one or more elements (E1, E2,.. En), said at least one load line (4) connecting said respective spool in parallel, a fitting for the connection of the tank to a low pressure line (T) of the modular directional valve device into which the return flow rates of utilities flow, a choke (2) arranged on a bypass line (LC) of the modular directional valve device downstream of a last element (En) of said one or more elements (E1, E2,.. En), said valve device further comprising a connection line (N) for connection, direct or indirect, to a control signal line of the pump (PA), said connection line (N) being adapted to draw the control signal on the bypass line (LC) between a last element (En) of the one or more elements and the choke (2), wherein a pressure regulator (5) is provided only in the bypass line (LC) and upstream of the first element (E1) of said one or more elements (E1, E2,.. En), the regulator (5) being configured so as to impose a constant pressure drop along the bypass line (LC) and through said one or more elements (E1, E2,.. En), the valve device being **characterized in that** said load line (4) is connected to said bypass line (LC) upstream said pressure regulator (5).

2. Valve device according to claim 1, **characterized in that** the pump (PA) is a variable displacement pump of the type with negative control system.

3. Valve device according to claim 1, **characterized in that** the pump (PA) is a variable displacement pump of the load sensing type.

Patentansprüche

1. Modulare Wegeventileinrichtung, ausgestattet mit einem oder mehreren Elementen (E1, E2, ... En), wobei die Ventileinrichtung zur Steuerung einer variablen volumetrischen Pumpe (PA) geeignet ist, wobei das eine oder die mehreren Elemente (E1, ... En) vom gekreuzten Typ sind und eine Verbindung zwischen der variablen volumetrischen Pumpe (PA) und einem Tank zu verschiedenen Diensten durch entsprechende Verwendungen (A1, B1, A2, B2) ermöglicht; wobei die Ventilvorrichtung mindestens eine Zufuhrlinie (P1) umfasst und die Ventilvorrichtung zur Verbindung mit der Pumpe (PA) durch die mindestens eine Zufuhrlinie (P1) angeordnet ist und ferner mindestens eine Ladelinie (4) zum Verbinden derselben an mindestens eine Versorgungsline (P1) zu den Diensten aufweist, wobei die mindestens eine Ladelinie (4) durch eine entsprechende Spule des einen oder der mehreren Elemente (E1, E2, ... En) verläuft, wobei die mindestens eine Ladelinie (4) durch paralleles Verbinden der jeweiligen Spule ein Anschlussstück zum Verbinden des Tanks mit einer Niederdruckleitung (T) der modularen Wegeventilvorrichtung, in dem die Rückflussraten der Dienste fließen, umfasst, mit einer Drossel (2), die auf einer Bypass-Linie (LC) der modularen Wegeventilvorrichtung stromabwärts eines letzten Elements (En) des einen oder der mehreren Elemente (E1, E2, ... En) angeordnet ist, wobei die Ventilvorrichtung ferner umfasst: eine Verbindungslinie (N) zum direkten oder indirekten Verbinden mit einer Linie eines Steuersignals der Pumpe (PA), wobei die Verbindungslinie (N) geeignet ist, das Steuersignal auf der Bypass-Linie (LC) zwischen einem letzten Element (En) aus einem oder mehreren Elementen (En) und der Drossel (2) abzuleiten, wobei nur in der Bypass-Linie (LC) und vor dem ersten Element (E1) des einen oder der mehreren Elemente (E1, E2, ... En) ein Druckregler (5) angeordnet ist, wobei der Regler (5) konfiguriert ist, um einen konstanten Druckabfall entlang der Bypass-Linie (LC) und durch das eine oder die mehreren Elemente (E1, E2, ... En), wobei die Ventilvorrichtung ist **dadurch gekennzeichnet, dass** die Ladelinie (4) stromaufwärts des Druckreg-

lers (5) mit der Bypass-Linie (LC) verbunden ist.

2. Ventileinrichtung nach Anspruch 1, **dadurch gekennzeichnet, dass** die Pumpe (PA) eine volumetrische variable Pumpe vom Typ mit Negativsteuerung ist.

3. Ventileinrichtung nach Anspruch 1, **dadurch gekennzeichnet, dass** die Pumpe (PA) eine volumetrische variable Pumpe vom Typ der Ladedetektion ist.

Revendications

1. Dispositif à vanne directionnelle modulaire, équipé d'un ou plusieurs éléments (E1, E2, ... En), ledit dispositif à vanne étant adapté à la commande d'une pompe volumétrique variable (PA), ledit ou plusieurs éléments (E1, ... En) étant de type croisé et permettant une connexion entre la pompe volumétrique variable (PA) et un réservoir, à des différents services au moyen d'utilisations respectives (A1, B1, A2, B2) ; ledit dispositif à vanne comprenant au moins une ligne d'alimentation (P1) et ledit dispositif à vanne étant disposé pour être connecté à la pompe (PA) par ladite au moins une ligne d'alimentation (P1) et comprenant en outre au moins une ligne de chargement (4) pour connecter ladite au moins une ligne d'alimentation (P1) aux services, ladite au moins une ligne de chargement (4) traversant une bobine respective dudit un ou plusieurs éléments (E1, E2, ... En), ladite au moins une ligne de chargement (4) connectant en parallèle ladite bobine respective, un raccord de connexion du réservoir à une ligne basse pression (T) du dispositif à vanne directionnelle modulaire, à l'intérieur duquel passent les débits de retour des services, un étranglement (2) étant disposé sur une ligne de dérivation (LC) du dispositif à vanne directionnelle modulaire, en aval d'un dernier élément (En) dudit un ou plusieurs éléments (E1, E2, ... En), ledit dispositif à vanne comprenant en outre : une ligne de connexion (N) pour se connecter directement ou indirectement à une ligne d'un signal de commande de la pompe (PA), ladite ligne de connexion (N) étant apte à dériver le signal de commande sur la ligne de dérivation (LC) entre un dernier élément (En) d'un ou plusieurs éléments et l'étranglement (2), où un régulateur de pression (5) est disposé seulement dans la ligne de dérivation (LC) et en amont du premier élément (E1) dudit un ou plusieurs éléments (E1, E2, ... En), le régulateur (5) étant configuré de manière à appliquer une perte de pression constante le long de la ligne de dérivation (LC) et à travers lesdits un ou plusieurs éléments (E1, E2, ... En), où le dispositif à vanne est **caractérisé en ce que** ladite ligne de chargement (4) est connectée à ladite ligne de dérivation (LC) en amont dudit régulateur de pression (5).

2. Dispositif à vanne selon la revendication 1, **caractérisé en ce que** la pompe (PA) est une pompe volumétrique variable du type avec un système à commande négative.

3. Dispositif à vanne selon la revendication 1, **caractérisé en ce que** la pompe (PA) est une pompe volumétrique variable du type à détection de chargement.

FIG. 1

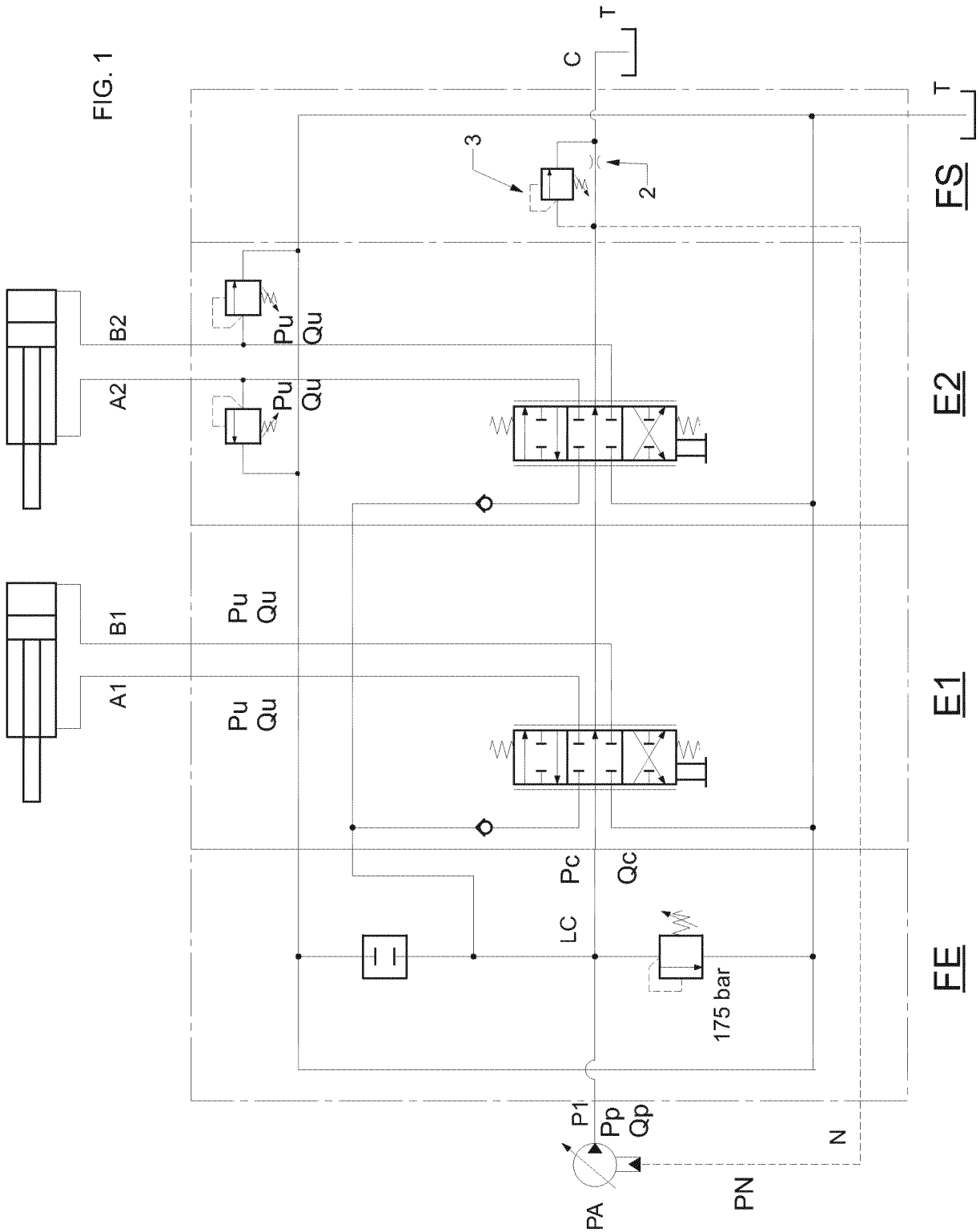
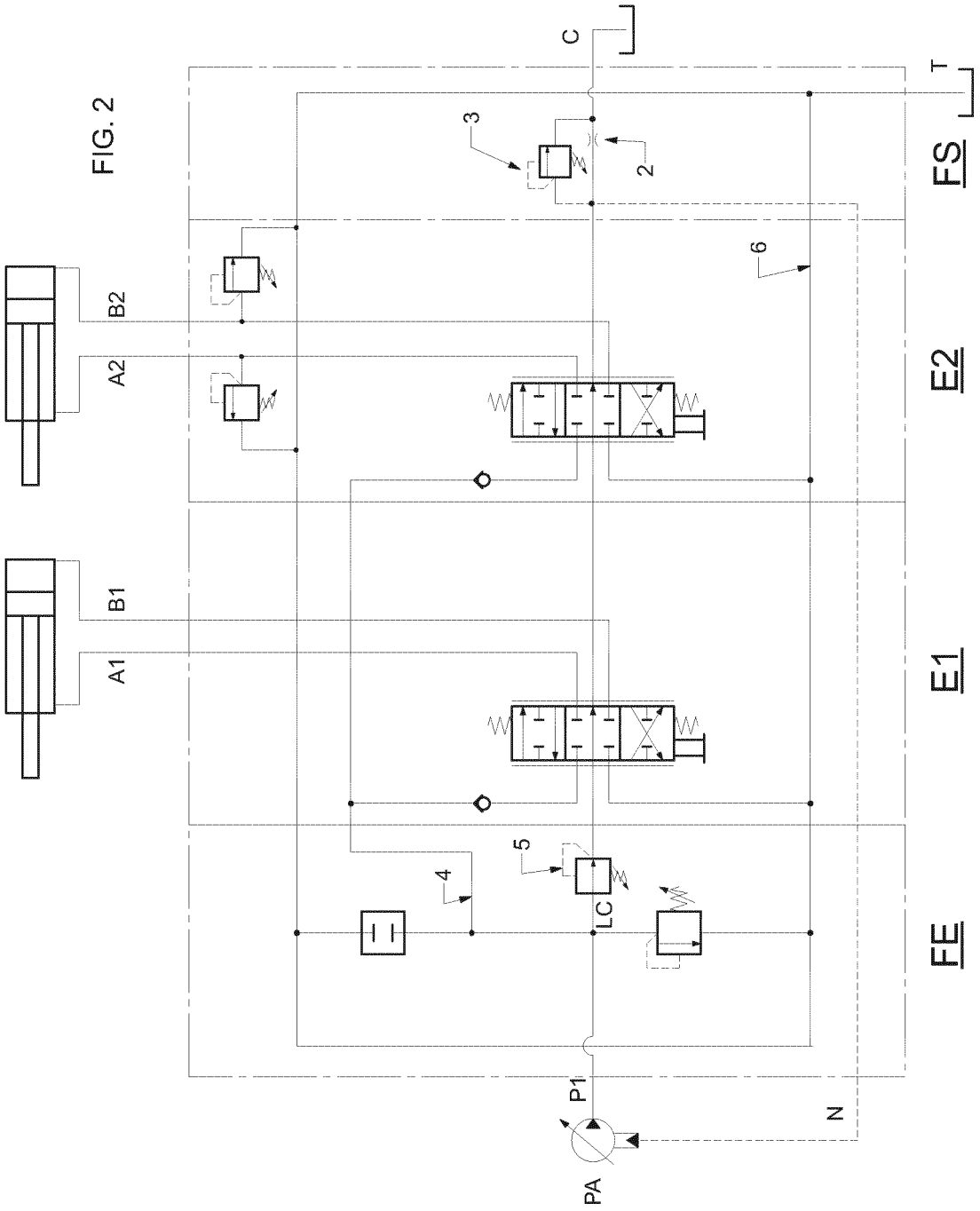

T
C
T
FS
3
2
B2
A2
Pu
Qu
Pu
Qu
E2
B1
A1
Pu
Qu
Pu
Qu
E1
Pc
Qc
LC
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FE
P1
Pp
Qp
N
PA
PN

FIG. 2



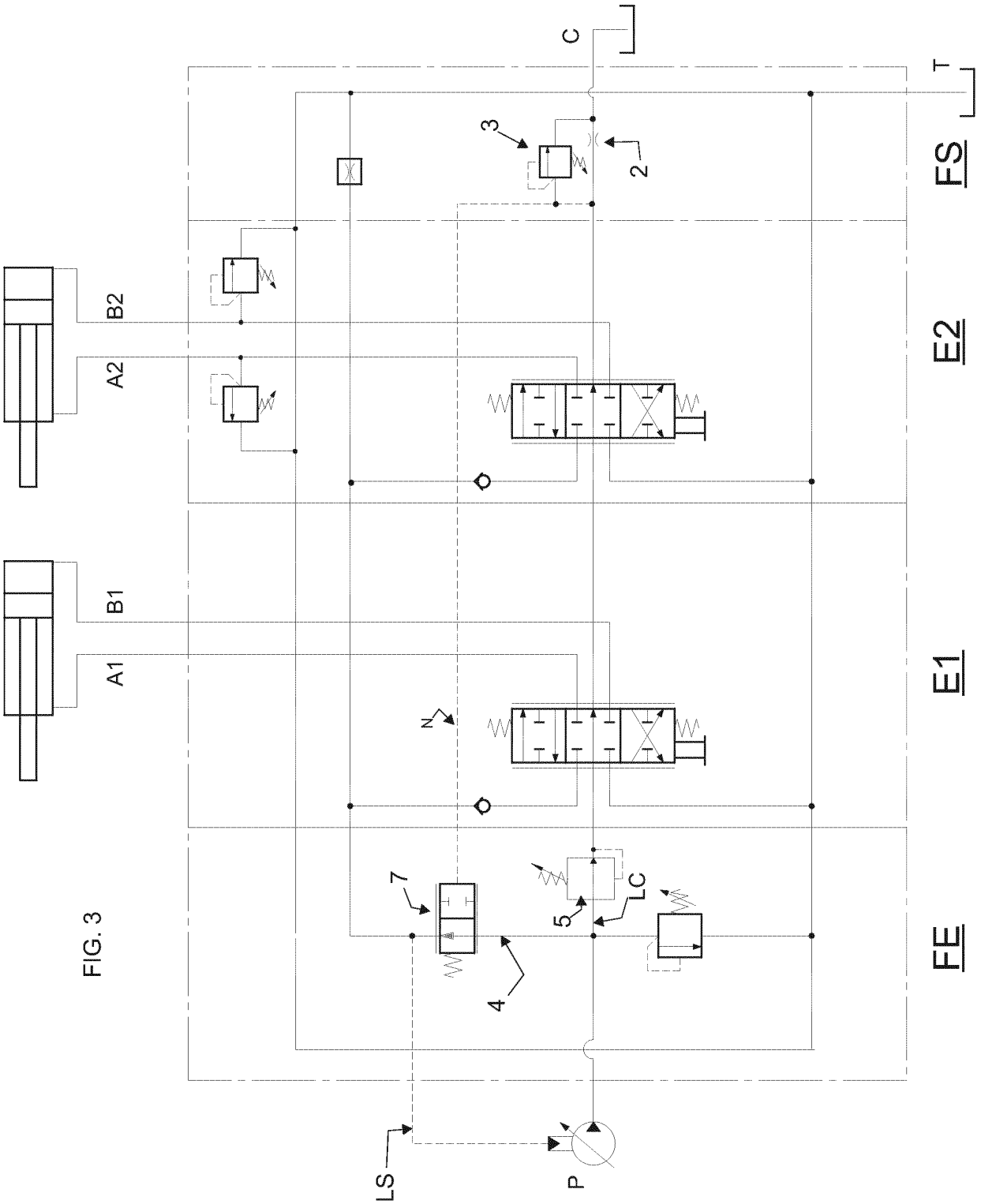


FIG. 3

FIG. 4

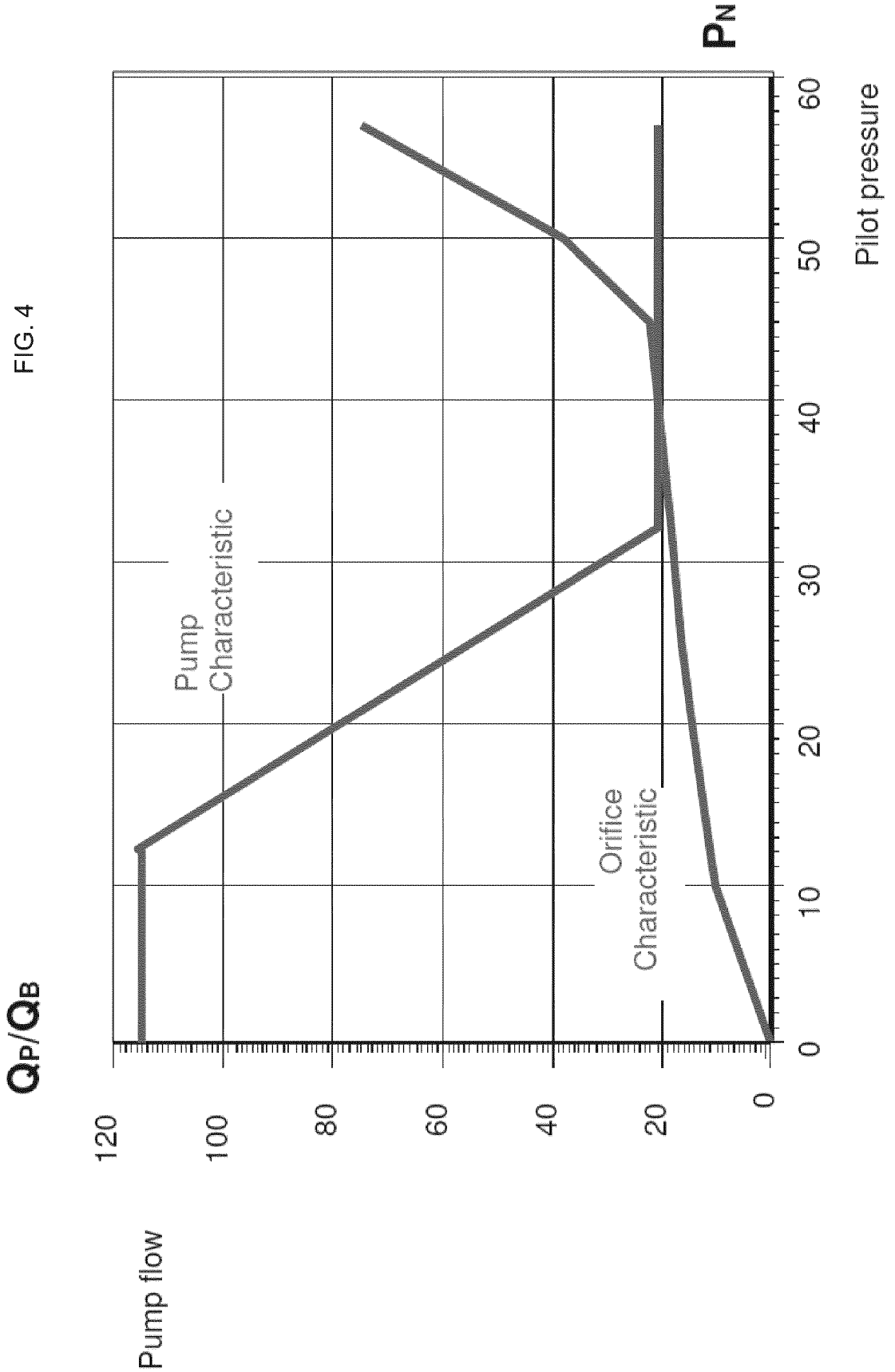
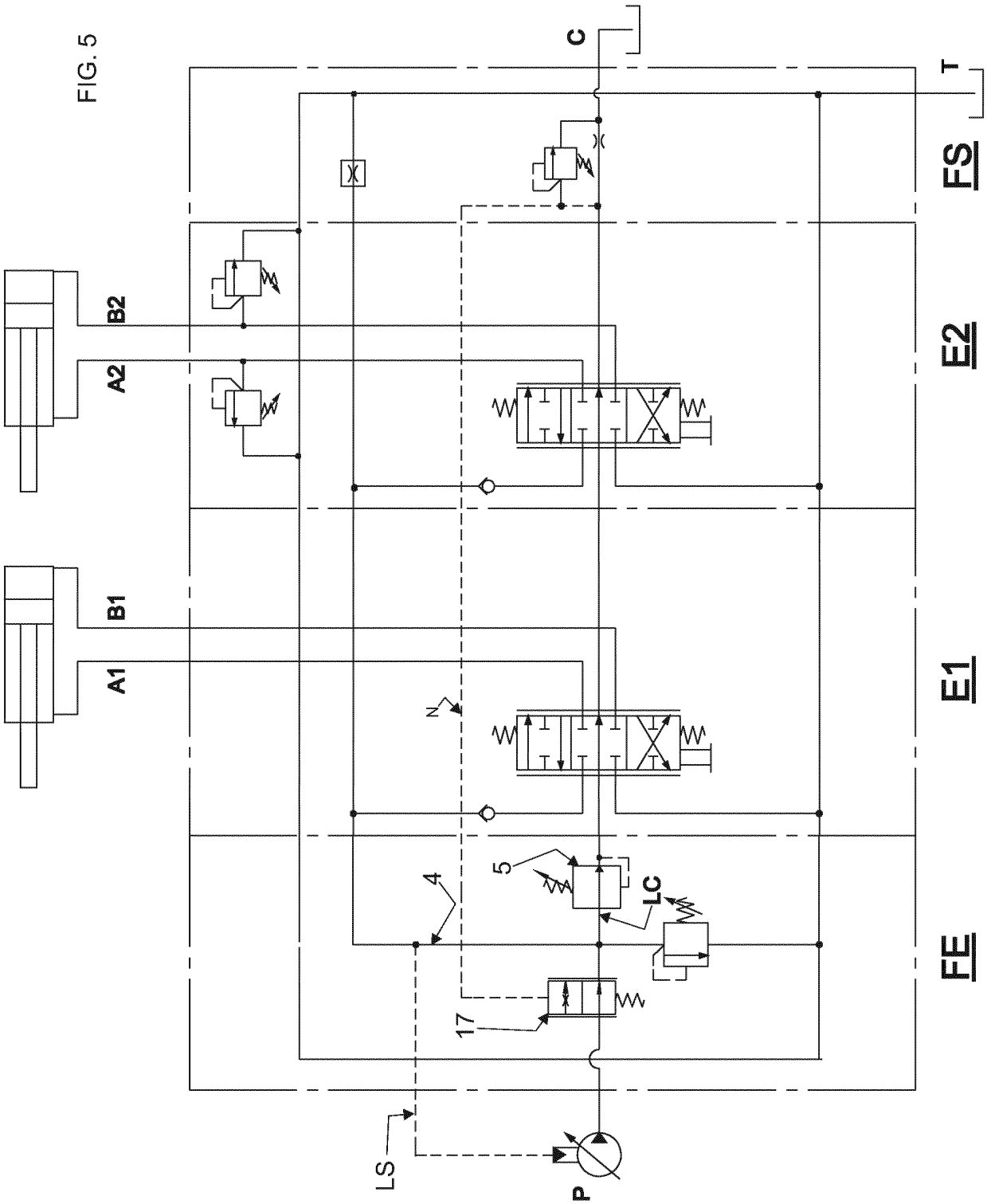

Q_P/Q_B
Pump flow
120
100
80
60
40
20
0
Pump Characteristic
Orifice Characteristic
0
10
20
30
40
50
60
P_N
Pilot pressure

Fig. 4

FIG. 5



REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

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