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(54) **HYDRAULIC DISTRIBUTOR WITH COMPENSATOR DEVICE FOR DIRECTIONAL VALVES AND HYDRAULIC CIRCUIT COMPRISING THE SAME**

(57) A hydraulic distributor comprises at least one main spool configured to define a delivery segment, and a discharge segment, a supply segment and a pressure compensator configured in such a way that acting on one of a first side thereof is a local pressure and acting on a second side is a maximum Load Sensing pressure either characteristic of the working pressure of the hydraulic user, in the case single hydraulic user is present, or, in the case of a plurality of hydraulic users are present, each defining a respective characteristic pressure, character-

istic of the maximum pressure among the characteristic pressures of the hydraulic users. The pressure compensator comprises at least three ways, of which a third way is configured in such a way as to connect the discharge segment with an energy recovery stretch connectable to an energy recovery device. The pressure compensator comprises a position sensor configured to detect the position of said pressure compensator and transmit it to a control unit operatively connected to the energy recovery device.

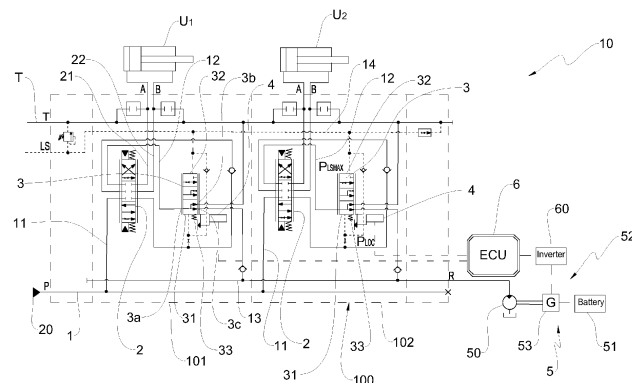


Fig. 1

Description

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FIELD OF APPLICATION

[0002] The present invention finds application in hydraulic systems, in particular but not exclusively in the sector of hydraulic distributors intended for operating hydraulic actuators using pressure compensation devices.

[0003] Within this sector, the invention refers to a hydraulic distributor of the type comprising at least one spool for operating a hydraulic user, e.g. a hydraulic actuator, and a pressure compensator.

TECHNOLOGICAL BACKGROUND

[0004] In off-highway applications, such as the one of excavators, a known problem is the one of energy losses due to the presence of compensators in the hydraulic distributors typically used in this sector.

[0005] Pressure compensation is in fact typically used in order to maintain a constant pressure drop at the ends of the regulating ports, thus enabling a precise flow rate control, independent of the load of the actuator and the simultaneous operation of several sections to be obtained. This allows the flow rate to be regulated so that it is only a function of the stroke of the main spool.

[0006] However, the intervention of local compensators results in a bottleneck of the meter in/out area, which leads to energy dissipation in the form of fluid-transmitted heat.

[0007] For this reason, it is advantageous to reuse the energy that would otherwise be dissipated through the local compensator by channelling, if the compensator itself allows it, a priority flow in a by-pass segment in order to be able to use it for energy recovery purposes. For example, such energy recovery may take place by redirecting the fluid of the by-pass segment being supplied, thereby making a regenerative connection, or by using it for recharging an accumulator or other energy recovery devices.

[0008] An example of a hydraulic circuit comprising an energy recovery accumulator used in a hydraulic lifting system is proposed in patent application DE3930553.

[0009] However, there is a need to optimise the management of the energy recovery function.

[0010] In particular, the known solutions allow only a passive management of this functionality, leaving that the priority flow intended for energy recovery is only connected to the operating conditions of the system. Likewise, the operation of the energy recovery unit in the known solutions does not provide any possibility of regulation, since it is also connected only to the priority flow redirected by the distributor.

[0011] On the contrary, it would be desirable to be able to allow a more active control of the energy recovery func-

tions and, in general, of the behaviour of the systems provided with this function.

SUMMARY OF THE INVENTION

[0012] The technical problem at the basis of the present invention is to make available a hydraulic circuit that is structurally and functionally conceived to overcome one or more of the limitations disclosed above with reference to the mentioned prior art.

[0013] In the context of this technical problem, one object of the present invention is to make available to the art a hydraulic distributor that is set up for a simple use in applications provided with energy recovery logics.

[0014] A further object is to make available a hydraulic circuit provided with a (at least) three-way compensator, capable of combining the usual flow regulation functions typical of the compensators with the ability to manage a priority flow aimed at energy-saving logics.

[0015] Still another object of the invention is to make available a hydraulic distributor in which the energy recovery functions can be regulated not only according to the boundary conditions of the hydraulic circuit in which the distributor operates, but also in a user-adjustable or otherwise modifiable manner according to specific operational requirements.

[0016] Such and other objects are achieved thanks to one or more of the features of the invention reported in the independent claims 1 and 8. The dependent claims outline preferred and/or particularly advantageous aspects of the invention.

[0017] According to a first aspect, the invention refers to a hydraulic distributor comprising at least one main spool for operating a hydraulic user, for example a hydraulic actuator, a supply segment for operating the hydraulic user, preferably configured to provide a delivery segment with a flow rate of operating fluid at a working pressure, and a pressure compensator.

[0018] Preferably the pressure compensator is configured in such a way that acting on a first side thereof is a local pressure, preferably taken at the delivery segment. Preferably acting on a second side of the pressure compensator is a maximum Load Sensing pressure either characteristic of the working pressure of said hydraulic user, in case it is operated individually, or, in case a plurality of hydraulic units being operated, each defining a respective characteristic pressure, characteristic of the maximum pressure among said characteristic pressures of the hydraulic users.

[0019] Preferably said hydraulic distributor comprises a position sensor associated with said pressure compensator. Said position sensor is preferably configured to detect the position of said pressure compensator and preferably transmit it to a control unit operatively connected with said energy recovery device.

[0020] Preferably the second side is opposite said first side.

[0021] Preferably said spool is configured to define a

delivery segment and a discharge segment.

[0022] Preferably said pressure compensator comprises at least three ways. Preferably a first way is connected to said discharge segment of the spool in such a way as to intercept the discharge segment itself. Preferably a second way is connected to discharge. Preferably a third way is configured in such a way as to connect said discharge segment with an energy recovery stretch connectable to an energy recovery device.

[0023] It will be appreciated that the hydraulic distributor of the present invention provides for the presence of a pressure compensator arranged in such a way as to intercept at least the discharge segment; a position sensor is associated with said compensator.

[0024] Preferably, the pressure compensator is configured in such a way that acting on a first side thereof is a local pressure (Ploc) taken at a stretch of the main delivery segment and acting on a second side thereof is a pressure corresponding to the maximum Load Sensing pressure (PLSmax) among the characteristic pressures of the hydraulic users operated by the distributor. In the event that a single working section, and hence a single hydraulic user, is operated, this pressure is representative of the pressure at which the user works. If more working sections and corresponding users are operated, the pressure on the second side of the compensator will be characteristic of the working section at the maximum pressure.

[0025] The compensator is preferably of the at least three-way type and one of these ways connects the discharge segment exiting the main spool with an energy recovery stretch connected to an energy recovery device.

[0026] The distributor further comprises a position sensor operatively associated with the pressure compensator so as to be able to detect the position of the pressure compensator itself and transmit it to a control unit operatively connected with the energy recovery device.

[0027] It will be appreciated that the presence of the position sensor makes it possible to transmit information about the position of the compensator to the control unit, using this information to regulate or set the operating modes in which the energy recovery device operates.

[0028] In light of the configuration of the distributor of the present invention, this regulation of the energy recovery device results in a consequent variation in the back pressure value of the energy recovery stretch, i.e. of the pressure upstream of the device. This pressure variation has an impact on the overall operating conditions of the circuit. In particular, the position of the pressure compensator will in turn be changed, bringing the system to a different equilibrium position, which will be read again via the position sensor to be transmitted to the control unit. The control unit can therefore be configured in such a way as to intervene on the energy recovery device and, more generally, on the pressure value of the energy recovery stretch, in such a way that the compensator is brought to a position corresponding to the most advantageous condition from the point of view of energy

recovery.

[0029] Typically, this position is the one in which the pressure compensator has its way connected to the discharge segment completely closed and its way connected to the energy recovery stretch minimally "choked". However, it will be understood that depending on the system configuration and the modes that are wished to be obtained, the control unit can be configured to set the desired behaviour of the pressure compensator towards a specific position. For example, the system can be set to be under a certain condition for a first time interval and under a second condition in a subsequent time interval. This different setting may also be associated with the charge level of an energy accumulator or other boundary conditions.

[0030] According to a further aspect, the invention also refers to the hydraulic circuit in which the aforesaid distributor connected to an energy recovery device and to a relative control unit is present.

[0031] In preferred embodiments, the energy recovery device may comprise regulating means configured to vary a back pressure value on the recovery stretch. In this way it is possible to condition the position of the compensator by varying the conditions within which the distributor operates as illustrated above.

[0032] In some embodiments, the energy recovery device may comprise a hydraulic motor activated by a fluid flow rate supplied via said energy recovery stretch in such a way as to supply energy to an energy storage device. Preferably, the regulating means are configured to vary the pressure upstream of the hydraulic motor.

[0033] In this way the energy can be efficiently stored thanks to the accumulator and to the regulation of the energy recovery device. The control unit can operate in such a way as to have the circuit work under the condition of maximum energy recovery as long as there is energy available to be supplied to the accumulator and as long as it can receive energy.

[0034] Preferably, the energy storage device comprises a rechargeable battery and the regulating means comprise an electric generator. The control unit is configured in such a way as to regulate resistant torque and/or speed values of the electric generator. In this way it is possible to vary the pressure conditions upstream of the hydraulic motor, that is, of the stretch connected to the pressure compensator, by means of a solution of simple implementation that allows to make available electrical energy that can be advantageously used in the operating context of the means on which the distributor and the circuit of the present invention are installed.

[0035] However, it will be understood that the energy storage device may also be of different types, for example of hydraulic type.

[0036] The distributor and the circuit of the present invention may further provide for numerous other preferred features, as indicated below and in the dependent claims of the present invention. It will be appreciated that these features apply to all aspects of the invention unless oth-

erwise indicated.

[0037] For example, in some preferred embodiments of the invention, the pressure compensator comprises a first way connected to the discharge segment of the spool, a second way connected to discharge, or to a tank of the hydraulic circuit, and a third way configured in such a way as to connect the discharge segment with the energy recovery stretch.

[0038] Thanks to the above configuration, the fluid flow rate provided through the supply segment can be directed to discharge or, if the working conditions allow it, partially or entirely to a recovery device by partialising or closing the discharge segment.

[0039] In some embodiments, the pressure compensator may further be arranged in such a way as to intercept both the delivery segment and the discharge segment. In other words, said pressure compensator is arranged in such a way as to respectively intercept said delivery segment and said discharge segment.

[0040] It will be appreciated that in the context of the present invention, the term "intercept" will be understood to mean that the pressure compensator is placed in an intermediate position of a respective segment, i.e. the delivery segment and/or the discharge segment. The segment is then interrupted to flow into the compensator, and then continue out of the compensator itself. Both the delivery segment and the discharge segment can be intercepted by the compensator.

[0041] In this way, the pressure compensator can act taking into account both the working conditions of the different sections activated by the distributor and taking into account the delivery conditions.

[0042] The compensator can therefore act by fully opening the delivery and discharge passage ports or by choking them, depending on the working conditions of the distributor. For example, in the event that the maximum Load Sensing Pressure (PLS_{max}) has a high value, for example due to the occurrence of a particular working condition, for example resulting from a high load being simultaneously activated on another user, the compensator will tend to choke the passage ports, by acting on both the delivery and on the discharge such to bring the hydraulic system back to an equilibrium situation without significant variations in the flow rate deriving therefrom.

[0043] It will be appreciated that in the context of the present invention the term to choke is used to indicate a decrease in the surface area of the passage ports.

[0044] A correct sizing and an appropriate timing of the opening ports defined by the stroke of the compensator spool, allow to optimise the operating conditions of a specific application.

[0045] According to a further aspect of the invention, the pressure compensator comprises a continuous-positioning spool, precisely allowing a continuous and precise regulation of the flow rate according to the actual working conditions.

[0046] In preferred embodiments, the pressure compensator comprises five ways, thereby enabling a par-

ticularly simple constructive solution to be realized. Preferably, the five ways comprise two inlet ways, one for the delivery and one for the discharge respectively, and two outlet ways, one for the delivery and one for the discharge respectively, and a fifth way that defines an energy recovery stretch connectable to an energy recovery device.

[0047] Preferably, in order to keep the compensator normally open, it may comprise an elastic element, for example a spring, acting on the first side.

[0048] According to yet another aspect, the local pressure is taken at a primary stretch of the delivery segment immediately downstream of the spool. Preferably, the primary stretch connects the spool with the pressure compensator. The delivery segment can also comprise a secondary stretch that again places the compensator in communication with the spool. This allows to optimise the overall dimensions of the distributor, simplifying the design thereof.

[0049] According to a further aspect, the compensator is arranged downstream, and preferably immediately downstream, of the main spool along the discharge segment.

[0050] In preferred embodiments, the compensator is arranged downstream, and preferably immediately downstream, of the main spool along the delivery stretch.

[0051] It will be appreciated that in the context of the present invention the term immediately downstream will be used to indicate that there are no further hydraulic components between the main spool and the compensator.

[0052] The above preferred features are applicable to all aspects of the present invention, in particular to the hydraulic circuit according to the further aspect of the invention mentioned above.

[0053] More generally, said purposes and advantages are all achieved by the hydraulic distributor, object of the present invention, which is characterized by the provisions of the following claims.

BRIEF DESCRIPTION OF THE DRAWINGS

[0054] This and other characteristics will be more apparent from the following description of certain embodiments illustrated by way of mere non-limiting example in the accompanying drawings, in which:

Figure 1 is a schematic illustration of a hydraulic circuit according to the present invention in an exemplary embodiment in which two working sections are provided; and

Figure 2 is a schematic illustration of a hydraulic circuit according to an alternative embodiment of the present invention.

DETAILED DESCRIPTION OF THE INVENTION

[0055] Referring initially to Figure 1, a hydraulic circuit comprising an oleodynamic distributor 100 according to

the present invention is illustrated as a whole with number 10.

[0056] The hydraulic circuit 10 is intended to operate one or more hydraulic users U1, U2,..., Un and comprises a supply group 20 intended to provide an operating fluid flow rate for the operation of such hydraulic users.

[0057] The supply group 20 can be of the variable flow rate or pressure type. However, solutions may be provided in which other solutions for regulating the supply group 20 may be used.

[0058] In some embodiments, the supply group 20 may comprise a variable displacement pump that regulates the flow rate based on the pressure characteristic of the user at a higher pressure among those supplied by the supply group. The example in Figure 1 illustrates the hydraulic system 10 in the case where the supply group 20 is intended to supply two hydraulic users U1, U2. It should be noted that there can still be an even larger number of users, as indicated above.

[0059] In the example represented in Figure 1, the two users U1, U2, are for example formed by double-acting hydraulic actuators. The hydraulic user U1 can however be represented by the actuation of any other hydraulic equipment. It will in fact be appreciated that the same inventive concepts set forth in connection with the present invention are also applicable to other solutions, like a hydraulic motor. For this reason, hereafter the term "hydraulic user" will be used to refer to any hydraulic equipment intended to be actuated by means of a hydraulic circuit with one or more working sections.

[0060] The supply group 20 is intended to provide the fluid required to operate these actuators, which is provided to them by means of the distributor 100. In the hydraulic system 10, a segment directed to tank is also defined, generically indicated by T, in which the operating fluid being discharged from the users flows.

[0061] In preferred embodiments, an energy recovery device 5 is also provided towards which the distributor 100 can direct part of the operating fluid according to ways that will be described in more detail below.

[0062] Still with reference to the example illustrated in Figure 1, the distributor 100 comprises a supply segment 1 connected to the supply group 20 and through which the fluid flow rate is directed to the individual sections of the distributor 100.

[0063] It will be appreciated that the distributor 100 may have a plurality of working sections 101, each one intended to operate a respective hydraulic user U1,..., Un.

[0064] In the embodiment illustrated in Figure 1, the distributor 100 comprises two working sections 101, 102, connected to a respective actuator or more generally to a respective hydraulic user U1, U2.

[0065] Preferably, each section 101, 102 comprises a spool 2 for operating the hydraulic actuator U1, U2 and a pressure compensator 3, the operating characteristics of which will be better illustrated below.

[0066] As can be seen, the spool 2 defines a delivery segment 11, connected to the supply segment 1, and a

discharge segment 12, for the management of the discharge flows. The spool 2 is configured in such a way as to operate the respective hydraulic user in one or the opposite direction depending on the position of the spool itself. For this purpose, a first connection stretch 21 and a second connection stretch 22 can be provided in the section 101, 102 to which the spool 2 sends the flow rate provided by the delivery segment 11, depending on the positioning of the spool 2.

[0067] The discharge segment 12 defined by the spool 2 is advantageously intercepted at the outlet of the spool 2, by the compensator 3.

[0068] The compensator 3 can therefore comprise at least three ways.

[0069] A first way 3a is connected to the discharge segment and intercepts the discharge segment 12 itself, a second way 3b is connected to discharge, that is to say to the segment connecting to the tank T and a third way 3c connects the discharge segment 12 with an energy recovery stretch 13 connected in turn to the energy recovery device 5.

[0070] As can be appreciated, therefore, in the circuit of the present invention, the compensator 3 makes it possible to compensate for the pressures present in the system as a function of the position of its continuously positioned spool.

[0071] In order to achieve the compensation required by the system, the pressure compensator 3 is advantageously configured such that acting on the first side 31 thereof is a local pressure PLoc taken at the delivery segment 11 and acting on the second side 32, opposite the first side 31 is a maximum Load Sensing pressure PLSmax.

[0072] Preferably, the local pressure PLoc is taken at a primary stretch 11b of the delivery segment 11 located downstream of said spool 2 and upstream of said pressure compensator 3, in the embodiment of Figure 2, and upstream of the users more generally. Preferably the pressure is taken immediately upstream of the compensator 3, i.e. there are no hydraulic components interposed between the point where the pressure PLoc is taken and the compensator 3.

[0073] In some embodiments, a spring, or other equivalent elastic element 33 further acts on the side 31 in addition to the local pressure PLoc.

[0074] With regard to the pressure PLSmax, in the present case, in which only one hydraulic user is present, this pressure corresponds to the pressure characteristic of the working pressure of the hydraulic user U1. On the other hand, in case a plurality of hydraulic users U1,...Un are present, the pressure PLSmax corresponds to the maximum Load Sensing pressure among all those characteristic of the hydraulic users present. This pressure is taken at a Load Sensing segment 14 which provides the supply group 20 with the Load Sensing signal.

[0075] In this regard, it will be appreciated that in the context of the present invention the term Load Sensing pressure denotes the pressure value characteristic of

each user that is sent to the supply group 20 to achieve flow rate regulation in the system, for example by regulating the displacement of the pump.

[0076] Therefore, acting on the side 32 is the maximum Load Sensing pressure determined by the operating conditions of each user U1,..., Un.

[0077] Thanks to this configuration, the compensator 3 can therefore make a continuous regulation based on the actual operating conditions of the system, moving the spool, and therefore compensating for the flow rates, so as to keep the system under a condition of dynamic equilibrium.

[0078] The position of the spool, and more generally of the pressure compensator 3, is also advantageously detected by a position sensor 4.

[0079] This position sensor, for example made by means of a position transducer, makes it possible to read the operating position of the pressure compensator 3, thus determining which ways are open and which are partially choked or closed.

[0080] This position sensor can be of the LVDT, Hall effect, potentiometric type, and in general any type suitable to be read and processed by the control unit.

[0081] With the use of a position sensor 4, it is in fact possible to evaluate the working modes of the compensator 3 itself.

[0082] Schematically, in fact, in a first position the compensator 3 diverts the flow simultaneously towards discharge and towards the energy recovery stretch. In a second position, the flow is directed only to the energy recovery device. In a third position, the way to the energy recovery device is also progressively choked or possibly closed.

[0083] This information can then be sent to a control unit 6 interfaced with the energy recovery device 5.

[0084] It will therefore be appreciated that, typically, in order to achieve a condition of maximum efficiency, favouring energy recovery as much as possible, the compensator is positioned between the first and the second position, that is, with the way 3b connected directly to discharge T completely closed and the way 3c, connected to the recovery stretch 13, minimally choked.

[0085] The positioning at this ideal point is achieved for specific load conditions, for back pressure of the recovery stretch 13 and for simultaneous movements.

[0086] It is, however, possible to condition the position of the compensator 3 by varying the boundary conditions, in particular the value of the pressure applied to the recovery stretch 13, which can be determined, for example, through an appropriate regulation of the energy recovery device made by means of the control unit 6.

[0087] Figure 1 illustrates an example embodiment of the energy recovery device 5, in which the use of a hydraulic motor 50 that drives an electric generator 53 is provided.

[0088] The hydraulic motor 50 is advantageously driven by a fluid flow rate provided through the energy recovery stretch 13 in such a way as to provide energy to

a rechargeable battery, or other energy storage device 51, by means of the electric generator 53.

[0089] The circuit may further comprise regulating means 52 configured to vary the pressure upstream of the hydraulic motor 50.

[0090] Such regulation can, for example, take place by using an inverter 60 associated with the generator 53 to regulate resistant torque and/or speed values thereof.

[0091] In this way it is possible to vary the pressure upstream of the hydraulic motor and consequently vary the position of the compensator.

[0092] In this mode of use, the presence of the position sensor 4 on the compensator 3 is a functional part for reading the status of the system and the correct feedback on the energy recovery device 5. In fact, the control unit 6 can process in real time the position of the compensator 3 detected through the sensor 4 and through a control algorithm, defined by the user depending on the application, it can vary the resistant torque and/or the speed of the generator and consequently bring the compensator 3 to its optimal working position.

[0093] From a practical point of view, in the example embodiment just described, by increasing the resistant torque of the generator 53, the pressure rises at the inlet of the hydraulic motor and on the recovery stretch 13. Consequently, the compensator 3 tends to open moving towards the first position described above.

[0094] By decreasing the resistant torque of the generator 53, the pressure at the inlet of the motor 50 and on the recovery stretch 13 decreases. Consequently, the compensator 3 tends to close moving towards the third position.

[0095] Similar operating concepts may also be extended to different embodiment solutions in which, for example, different means are used for pressure regulation, or the energy is stored in hydraulic form.

[0096] In alternative embodiments of the present invention, one of which is for example illustrated in Figure 2, the compensator 3 intercepts both the discharge segment 12 and the delivery segment 11 defined by the spool 2.

[0097] This embodiment will be described below only in relation to the characteristics that differentiate it from that previously described. It is understood that all the characteristics relating to the first embodiment are also preferred characteristics for this variant.

[0098] Referring therefore to Figure 2, the spool 2 preferably intercepts the delivery segment 11 defining a connection stretch 11a that brings the fluid to the spool 2 and a primary stretch 11b that connects the spool 2 to the pressure compensator 3.

[0099] According to the present embodiment, the compensator 3 is of the type having at least five-ways.

[0100] Preferably, in addition to the three ways described in relation to the previous embodiment, a fourth way 3d and a fifth way 3e intercept the delivery segment 11. The fourth way 3d is in particular connected to the primary stretch 11b, while the fifth way 3e is connected

to a secondary stretch 11c of the delivery segment 11, which brings the flow rate of operating fluid back to the main spool 2 after passing through the compensator 3.

[0101] This flow rate of operating fluid can then be sent to the hydraulic user Un, operating it in one or the opposite direction depending on the position of the main spool 2 in the same way as illustrated above via the connection stretches 21 and 22.

[0102] As previously illustrated, the compensator 3 allows to choke the passage of the fluid both along the delivery stretch and along the discharge stretch.

[0103] In other words, the passageways 3a, 3b, 3c, 3d and 3e are configured such as to define a passage port of the delivery segment and a passage port on the discharge segment.

[0104] These passage ports can be choked according to the position of the spool of the compensator 3 which position is read by means of the position sensor 4 in order to be sent to the control unit 6 with an operating principle similar to the previously described embodiment.

[0105] In preferred embodiments, the passageways 3a, 3b, 3c, 3d and 3e are configured such that the passage port on the discharge segment 12 has a smaller surface area than said passage port defined on the delivery segment 11.

[0106] In this case, assuming that the delivery and discharge flow rates are the same (user/actuator with equal areas), the compensation will mainly occur on the discharge segment, but the share part of compensation on the delivery segment can help reduce the undesirable effects of increased pressures and system instability.

[0107] Different sizings of the ports advantageously allow to obtain different behaviours in the compensator and in general in the system.

[0108] Also in this case, therefore, the control unit can operate according to specific algorithms that will allow to optimise the energy recovery functions according to the specific operating needs or to the specific application.

[0109] It will therefore be appreciated that the circuit of the present invention allows the compensation and energy recovery functions to be realised effectively, with a high degree of versatility and efficiency in handling the different operating conditions.

Claims

1. Hydraulic distributor (100) comprising:

- at least one main spool (2) for operating a hydraulic user (U1), for example a hydraulic actuator, said spool (2) being configured to define a delivery segment (11), and a discharge segment (12);
- a supply segment (1) configured in such a way as to provide the delivery segment (11) with a flow rate of operating fluid at a working pressure (P), for operating the hydraulic user (U1);

- a pressure compensator (3) configured in such a way that acting on a first side (31) thereof is a local pressure (PLoc) taken at the delivery segment (11) and acting on a second side (32), opposite to said first side (31), is a maximum Load Sensing pressure (PLSmax) either characteristic of the working pressure of said hydraulic user (U1) in the case it is individually operated, or in the case of a plurality of hydraulic users (U1,...Un) being operated, each defining a respective characteristic pressure, characteristic of the maximum pressure among said characteristic pressures of the hydraulic users (U1,...Un),

- said pressure compensator (3) comprising at least three ways, a first way (3a) connected to said discharge segment (12) of the spool (2) in such a way as to intercept the discharge segment (12) itself, a second way (3b) connected to discharge (T), and a third way (3c) configured in such a way as to connect said discharge segment (12) with an energy recovery stretch (13) connectable to an energy recovery device (5),

characterized in that it comprises a position sensor (4) associated with said pressure compensator (3), said position sensor (4) being configured to detect the position of said pressure compensator (3) and transmit said position of said pressure compensator (3) to a control unit (6) operatively connected with said energy recovery device (5).

2. Hydraulic distributor (100) according to claim 1, wherein said pressure compensator (3) is arranged to intercept said delivery segment (11) and said discharge segment (12) respectively.
3. Hydraulic distributor (100) according to claim 1 or 2, wherein said pressure compensator (3) comprises five ways (3a, 3b, 3c, 3d, 3e).
4. Hydraulic distributor (100) according to any one of the preceding claims, wherein said pressure compensator (3) comprises an elastic element (33) acting on said first side (31).
5. Hydraulic distributor (100) according to any one of the preceding claims, wherein said local pressure (PLoc) is taken at a primary stretch (11b) of the delivery segment (11) located downstream of said spool (2) and upstream of the associated hydraulic user and preferably, upstream of said pressure compensator (3).
6. Hydraulic distributor (100) according to claim 5, wherein said delivery segment (11) comprises a secondary stretch (11c) further connecting said pressure compensator (3) with said spool (2), said com-

pensator being interposed between said primary stretch (11b) and said secondary stretch (11c).

7. Hydraulic distributor (100) according to any one of the preceding claims, wherein said compensator (3) is arranged immediately downstream of said main spool (2) along said delivery stretch (11) and along said discharge segment (12). 5

8. Hydraulic circuit (10) comprising a hydraulic distributor (100) according to any one of the preceding claims, an energy recovery device (5) connected to said energy recovery stretch (13), and a control unit (6) operatively connected to said energy recovery device (5) in such a way as to control said energy recovery device (5) according to the position of the pressure compensator (3) detected by said a position sensor (4). 10 15

9. Hydraulic circuit (10) according to claim 8, comprising regulating means (52) configured to change a pressure value upstream of said energy recovery device (5) along said energy recovery stretch (13). 20

10. Hydraulic circuit (10) according to claim 8 or 9, wherein said energy recovery device (5) comprises a hydraulic motor (50) activated by a fluid flow rate supplied via said energy recovery stretch (13) in such a way as to supply energy to an energy storage device (51), said regulating means (52) being configured to vary the pressure upstream of the hydraulic motor (50). 25 30

11. Hydraulic circuit (10) according to claim 9, wherein said energy storage device (51) comprises a rechargeable battery and said regulating means (52) comprise an electric generator (53), said control unit (6) being configured to regulate drag torque and/or speed values of said electric generator (53). 35 40

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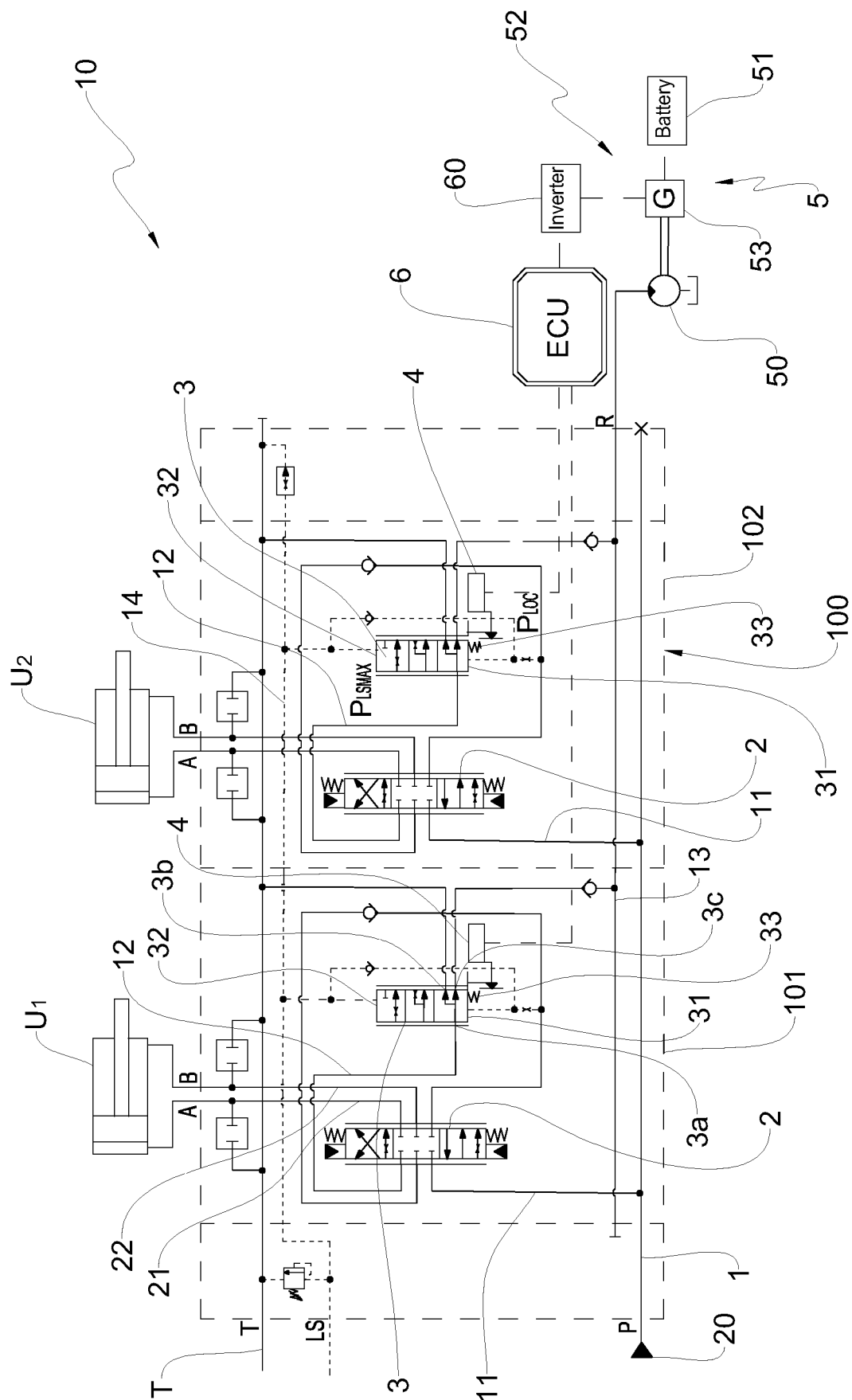


Fig. 1

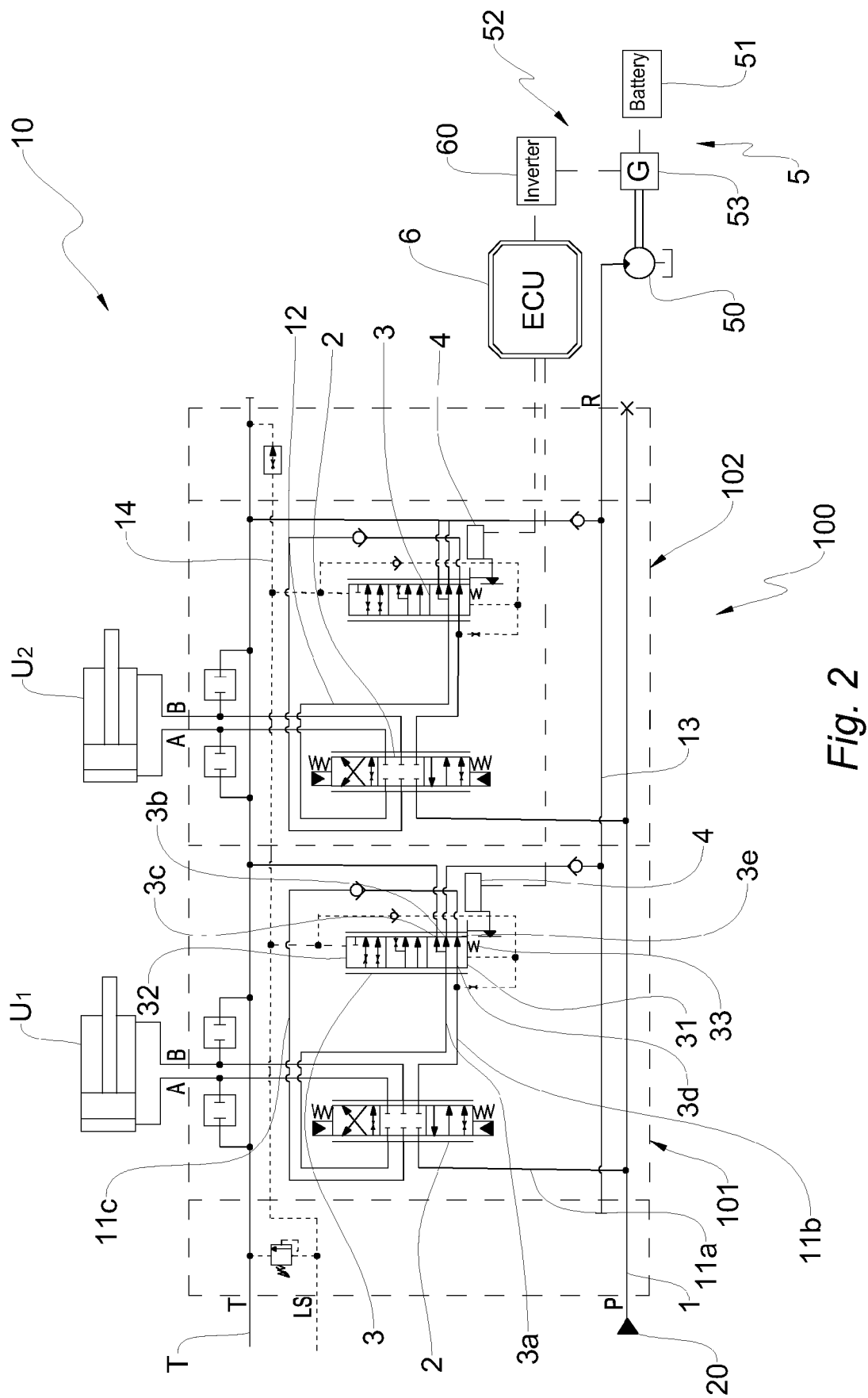


Fig. 2



EUROPEAN SEARCH REPORT

Application Number

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A	* figure 6; examples 2, 1, 10, 150, 27, 26, 3, 11, 13, 103 *	2, 5-11	F15B11/05 F15B11/16 F15B21/14
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A	* figure 4; examples 12, 22, 33, PFS, 34, PLS, 103 *	2, 5-11	
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A	* p.1, li. 12-17, p.2, li.4-8;p.5, li.13-24;p. 5, li.26-31;p.6 li. 12-16;; figure 2; examples 15,23,P,T,S,A,17 *	8	
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Place of search Munich		Date of completion of the search 11 October 2022	Examiner Deligiannidis, N
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