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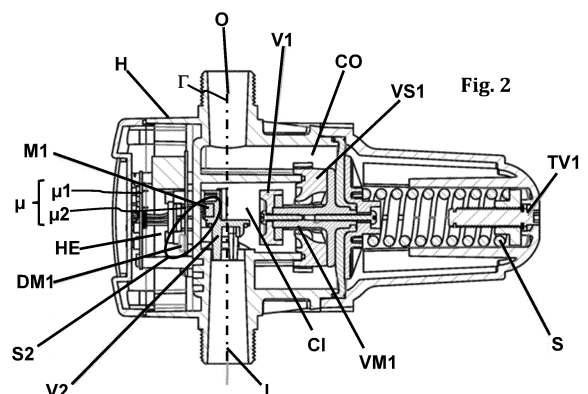
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Remarks:

The applicant has filed a text with which it is intended to bring the translation into conformity with the application as filed (Art. 14(2) EPC).

(54) **DEVICE FOR CONTROLLING THE TURNING ON AND OFF OF A HYDRAULIC PUMP, AND SYSTEM PROVIDED WITH THIS DEVICE**

(57) Control device (D) for an hydraulic pump and for regulating/adjusting/reducing the output pressure (P_{work}), comprising a housing (H) wherein are defined a fluid inlet (I) and a fluid outlet (O), an inlet chamber (CI) connected to the inlet (I), an outlet chamber (CO) connected to the outlet (O), a valve (V1) for reducing the pressure, a pressure sensor (S1) of the outlet (O), a flux sensor (S2), a controller (μ) to which are connected the sensors (S1, S2), where the controller (μ) is configured for sending an activation signal (B_{on}) to the hydraulic pump when the pressure sensor (S1) detects the transition of a pressure (P_s) higher than a determined threshold pressure (P_{on}) to a pressure (P_i) lower than the threshold pressure (P_{on}), such that the regulation pressure (P_{work}) is independent from the threshold pressure (P_{on}). The invention also relates to a system provided with the device.



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Description

TECHNICAL FIELD

[0001] The present invention belongs to the sector of the devices for controlling the start and stop of a pump in a water distribution network, which presents advantages in the transient processes for activation and shutdown with respect to the devices of the state of the art.

BACKGROUND OF THE INVENTION

[0002] Known in the hydraulic sector are the control devices for activation/shutdown of a hydraulic pump, comprising a housing wherein are defined an inlet of fluid and an outlet, an inlet chamber connected to the inlet, an outlet chamber connected to the outlet and a delivery pressure regulation valve arranged between the inlet chamber and the outlet chamber and a non-return valve arranged between the inlet and the inlet chamber, as described in patent document EP 0 539 721 A1.

[0003] In this device there is also a flow detector arranged between the outlet chamber and the outlet. This detector carries with it a magnet, intended to be detected by a sensor arranged in a housing in which the electronics are also located, the latter connected to a PC control panel accessible by a user. It also comprises a pressure detector consisting of a magnet mounted on the stem of the regulating valve.

[0004] One of the operating modes of this device is to turn on by detecting a minimum flow. In this mode, if on the demand side, that is, downstream, a valve or a tap is opened, the moving part of the flow detector moves and the displacement of its magnet is detected by the sensor, which is next to it. once connected to the control board. The control board sends an activation signal to the pump, which turns on, 'immediately' as stated in the text of the aforementioned application.

[0005] A major drawback of this immediate reaction capacity is that it does not take advantage of the installation's accumulation capacity, which can lead to much more frequent starts with consequent wear.

[0006] Another planned mode of operation is that the activation of the pump is carried out by detection of a minimum pressure by the aforementioned pressure detector, that is, the detector that is mounted on the valve stem. In this operating mode, when a pressure drop is detected to the predetermined pressure for activation, an activation signal is sent to the pump. This pressure for activation, therefore, is totally linked, and not adjustable, to the regulation pressure, since said detector is mounted on the regulation valve.

[0007] The fact that these two pressures are linked in a non-adjustable way can also lead to frequent starts/stops of the pump, since the predetermined pressure for activation cannot be regulated and should practically coincide with the regulation pressure to guarantee a start-up. similar in speed to that activated by flow de-

tection. This characteristic causes any decrease in pressure of the downstream installation to cause sudden and frequent starts of the pump with consequent damage to it.

DESCRIPTION OF THE INVENTION

[0008] To overcome the drawbacks mentioned in the previous section, the present invention provides a control device for activation/deactivation of an hydraulic pump and for regulating/adjusting/reducing the output pressure, comprising:

- a housing wherein are defined a fluid inlet and a fluid outlet;
- an inlet chamber connected to the inlet;
- an outlet chamber connected to the outlet;
- a valve for reducing the pressure arranged between the inlet chamber and the outlet chamber;
- a non-return valve arranged between the inlet and the inlet chamber;
- a pressure sensor in the outlet;
- a flux sensor associated to the non-return valve;
- a controller to which are connected the sensors,

wherein the controller is configured for sending an activation signal to the hydraulic pump when the pressure sensor detects the transition of a pressure higher than a determined threshold pressure to a pressure lower than the threshold pressure, such that the output pressure is independent from the threshold pressure.

[0009] This disconnection involves having a pressure sensor at the outlet and configuring the start-up step from a pressure higher than a certain threshold pressure (P_{on}) to a pressure lower than said threshold pressure. That is, the pump will not turn off due to a reverse evolution of the pressure, that is, from a pressure lower than the threshold pressure to a pressure higher than said threshold pressure. The order to turn off the pump will come from non-detection of flow, that is, it will be the flow sensor associated with the non-return valve who will determine the turn off of the pump.

[0010] That is, according to the present invention, a constant pressure is guaranteed in the circuit and stability is achieved since repetitive start-ups of the pump are minimized, which can occur in cases of leaks. As the present invention allows establishing a much lower start-up pressure (P_{ON}), the accumulation capacity of the hydraulic system can be advantageously taken advantage of, that is, the pressurized hydraulic head or accumulation capacity of the installation, or what can be known such as the elasticity of the installation (including the membrane of the device itself, the elasticity of the pipes or accumulation boilers arranged downstream of the device).

[0011] In some embodiments, the controller is configured for automatically adjusting the threshold pressure for activation as a function of a detected working pressure. Now, as there may be modifications in the working

pressure (P_{work}) due to slight modifications or readjustments of the installation, it can be expected that the microcontroller incorporates self-learning functions to readjust the threshold pressure for activation.

[0012] In some embodiments, the automatic adjustment is carried out the first time the device is used, by establishing the threshold pressure through:

$$P_{on} = P_{work} - \Delta p \quad (I)$$

where Δp is a value stocked in the controller.

[0013] In some embodiments, the detected working pressure (P_{work}) is the pressure detected by the pressure sensor just after detecting a flux interruption by the flux sensor after a pump stop.

[0014] In some embodiments, the controller is configured for sending an alarm signal if the pressure detected by the pressure sensor detects the transition to a pressure lower than a determined minimum pressure of pressure loss.

[0015] In some embodiments, the controller is configured for sending an alarm signal if the pressure detected by the pressure sensor detects the transition to a pressure higher than a determined maximum pressure of excessive pressure in the installation.

[0016] In some embodiments, the controller is configured for sending a deactivation signal to the pump it is detected at least a predetermined successive activations number in a predetermined time period, in order to protect the installation in case of accumulation capacity loss thereof. In some embodiments, the device does not comprise a flux detector arranged between the regulation valve de pressure and the outlet.

[0017] In some embodiments, the regulation valve comprises a mobile valve body, a valve seat, a spring and a regulating screw of the spring force.

[0018] In some embodiments, the flux sensor associated to the non-return valve is composed by a magnet mounted on the non-return valve and a detector of the magnet mounted on the controller, the detector being preferably a Hall sensor or a *Reed Switch*.

[0019] Preferably, the inlet and the outlet are arranged in the same axis, and advantageously the device comprises a housing de the housing arranged opposite the regulation valve with respect to the axis, the controller being housed in this housing.

[0020] In some embodiments, the controller is distributed between a control board, and a power board connected therebetween, the control board being provided with the user interface, the power board being provided with the power electronics components.

[0021] Finally, the pressure sensor is a pressure transducer, although it could also be a mechanical pressure sensor.

BRIEF DESCRIPTION OF THE FIGURES

[0022] To complement the description and in order to help a better understanding of the characteristics of the invention, in accordance with an example of practical implementation thereof, a set of non-limiting figures wherein for illustrative purposes is attached as an integral part of the description, the following has been represented:

Figure 1 is a perspective view of the device according to the invention.

Figure 2 is a section of the device which allows to appreciate the arrangement of its components.

Figure 3 shows the relevant pressures to understand the operation of the device and their relative values.

Figure 4 shows another section according to a cut which allows to appreciate the arrangement of the pressure sensor of the outlet.

Figure 5 shows an embodiment in which the device comprises a detector of the opening position of the regulation valve.

Figure 6 shows a system according to the invention intended for the control of two pumps in parallel with a single device.

Figure 7 shows a system according to the invention intended for the control of two pumps in parallel with two interconnected devices.

DESCRIPTION OF SOME EMBODIMENTS OF THE INVENTION

[0023] First of all, the following pressures are defined, to understand the operation of the device:

[0023] P_{work} : is the regulation pressure or work of the device. It is a pressure that can be regulated with the device (so it could also be called regulated pressure), which will be determined by the installation arranged downstream, the pump the device itself and in particular the degree of closure of the valve for reducing the pressure, on which the installer can act. In figure 3, 3 bars are given as an example of this pressure.

[0024] P_{on} : is a threshold value (adjustable) stored in the memory of the controller μ , and which is lower than the work pressure. It is a pressure value with which the pressure values measured by the pressure sensor arranged in the outlet of the device are compared. In figure 3, 1.5 bars are given as an example of this pressure.

[0025] P_{AL1} : is a value stored in memory (also adjustable) relative to a minimum pressure below which it is considered that the system should not work, in order to protect the pump. In figure 3, 0.5 bars are given as an example of this pressure.

[0026] P_{AL2} : is a value stored in memory (also adjustable) relative to a maximum pressure above which the system should not work, in order to protect the installation arranged downstream of the device D. Figure 3 is given as an example of this pressure 6 bars.

[0027] As seen in figures 1 and 2, the invention refers to a control device D for activation/deactivation of a hydraulic pump and for regulating/adjusting/reducing the output pressure P_{work} , comprising:

- a housing H wherein an inlet I of fluid and an outlet O are defined; this housing H houses and protects the components of the device.
- an inlet chamber CI connected to the inlet I;
- an outlet chamber CO connected to the outlet O;
- a valve V1 for reducing the pressure arranged between the inlet chamber CI and the outlet chamber CO;
- a non-return valve V2 arranged between the inlet and the inlet chamber CI;
- a pressure sensor S1 in the outlet O;
- a flux sensor S2 associated to the non-return valve V2; It is highlighted that this is a sensor in the most general sense and that it has at least the capacity to detect a minimum flow, that is, whether there is flow or not.
- a controller μ to which the sensors S1, S2 are connected. The controller is the unit comprising the control and power components, the first understood as those that manage the information (including the inputs by the user) and the second understood as those related to higher power signals, such as relays, power strips, connection, coils or capacitors.

[0028] According to the invention, the controller μ is configured for sending an activation signal B_{on} to the hydraulic pump when the pressure sensor S1 detects the transition of a pressure P_s higher than a determined threshold pressure P_{on} to a pressure P_i lower than the threshold pressure P_{on} , such that the output pressure P_{work} is independent from the threshold pressure P_{on} .

[0029] This is illustrated in figure 3. The mention of the upper pressures P_s and lower P_i is intended to explain that this is a step detection (illustrated by the downward arrow in figure 3) by a pressure P_{on} when the pressure detected is going down. That is to say, these are not predetermined pressures, but rather measured pressure values, and their comparison with P_{on} will cause the device D, specifically its controller μ , to send a start-up signal destined for the pump.

[0030] According to another embodiment, the control-

ler μ is configured for automatically adjusting the threshold pressure P_{on} for activation as a function of a detected working pressure P_{work} . Since the working pressure is a value that corresponds to a specific operating point of the demand/supply set, it cannot be predicted a priori. Therefore, a first automatic calibration procedure is provided that consists of putting the system in operation, measuring the working pressure P_{work} , and then establishing, for the subsequent operation of the device, a threshold pressure P_{on} for activation which will be obviously lower than the working pressure.

[0031] One way to perform the automatic adjustment the first time the device is used, by establishing the threshold pressure P_{on} through

$$P_{on} = P_{work} - \Delta p \quad (I)$$

where Δp is a value stocked in the controller μ .

[0032] This operation can also be performed manually by a user.

[0033] It is highlighted that as detected working pressure P_{work} , one could also consider the pressure detected by the pressure sensor S1 just after detecting a flux interruption by the flux sensor S2 after a pump stop.

[0034] According to another advantageous function of the device, the controller μ is configured for sending an alarm signal and to stop the pump if the pressure detected by the pressure sensor S1 detects the transition to a pressure lower than a determined minimum pressure P_{al1} of pressure loss. Figure 3 shows this pressure as a pressure lower than the others. This situation can occur due to a major break in pipes downstream of the installation.

[0035] And according to another additional function, the controller μ is configured for sending an alarm signal and to stop the pump if the pressure detected by the pressure sensor S1 detects the transition to a pressure higher than a determined maximum pressure P_{al2} of excessive pressure in the installation. It is about a pressure higher than all the others. The occurrence of a high pressure situation can occur due to breakage of the regulation device itself, which no longer fulfills its purpose for reducing the pressure.

[0036] As shown in figure 2, and as is known by itself, the regulating valve V1 comprises a mobile valve body VM1, a valve seat VS1, a spring S and a regulating screw TV1 of the force of the spring S.

[0037] Regarding the flux sensor S2 associated to the non-return valve V2, is composed by a magnet M1 mounted on the non-return valve V2 and a detector DM1 of the magnet M1 mounted on the controller μ , the detector DM1 being preferably a Hall sensor or a *Reed Switch*.

[0038] A housing HE of the housing H arranged opposite the regulation valve V1 with respect to the axis Γ , the controller μ being housed in this housing HE, is also an arrangement known in itself. Now, preferably the controller μ is distributed between a control board μ_1 , and

a power board $\mu 2$ connected therebetween, being the control board $\mu 1$ provided with the user interface HMI, being the power board $\mu 2$ provided with the power electronics components.

[0039] As illustrated in Figure 4, pressure sensor S1 is a pressure transducer, which is connected through a conduit to the outlet of the device.

[0040] According to another embodiment of the invention, illustrated in Figure 7, two or more devices can be connected to make a pressure group provided with two or more pumps in order to increase the flow supply capacity at constant pressure downstream. These pumps will operate in cascade and alternation in the order of start-up.

[0041] In this case the operating sequence would be described below:

There are two devices connected through a cable between the control circuit of device one D1 and the control circuit of device two D2. In this way, the software of said invention will be able to have information on the operation of both devices and make the different decisions necessary for the pressure group to function properly.

[0042] Initially it will be regulated to identical PWORK pressure on the two devices, through the regulating screw (which will be reflected in the pointer of the bell). As for the PON pressure, it can be configured manually on each device or the software will decide said pressure as a function of the PWORK pressure, which in any case will be the same for both devices.

[0043] When the downstream installation begins to have consumption needs, the first pump B1 will be put into operation through the device one D1. This will maintain the pressure constant downstream as long as the consumption remains within the flow curve of the first pump B1 (controlled by the device one D1). When the consumption increases and exceeds the supply capacity of the first pump B1, the pressure PWORK will not be able to be maintained therefore the pressure sensor of the device one will detect this pressure loss and the electronic circuit will send a start signal to device two D2 starting the second pump B2.

[0044] When the opposite happens, that is, the water consumption decreases, until the use of a second pump is no longer necessary, the system must decide when to dispense with one of the two pumps. To do this, the device must be able to analyze the drop in power consumption of the pumps and make decisions through an appropriate algorithm. The procedure consists of detecting the power consumption of the second pump B2 at the time of its start-up and, when it is detected that said power has decreased below a pre-established value, it is stopped.

[0045] To do this, said device, as shown in figure 5, has several sensors to regulate the operation of the second pump B2 of the pressure group:

- Pressure sensor S1 mentioned above.
- Flux sensor S2;

- Current sensor DM4.

[0046] Through this flux sensor, shown in figure 2, equipped with a magnet M1 and a detector of said magnet DM1 (preferably a hall effect sensor or a reed switch) the flow detection is controlled to stop the operation of the pump. once the flow has stopped circulating through the device (due to the closure of all downstream consumption points).

[0047] Through the current sensor, the circuit of the device of the invention is capable of analyzing the power consumed of the pump. This power is proportional to the flow that moves said pump, this being greater the greater the flow that said pump must move. With this detector the device is capable of analyzing the flow rate that is being used at all times.

[0048] According to another embodiment of the invention, which is illustrated in Figure 6, a single device D can be connected electrically to two pumps and hydraulically to a manifold that communicates the flow of the two pumps, to achieve a pressure group working in "duty" mode. -standby" at constant pressure. In this type of system, both pumps never work simultaneously but instead alternate their operation. The redundancy in the pumps allows guaranteeing the water supply in case of failure of one of them. The alternation in the start-up order ensures that the aging of the pumps is similar.

[0049] Through the use of two independent relays and the development of suitable software this realization can be achieved.

[0050] In summary, the device of the invention presents the following advantages in relation to the already known systems with variable speed controllers:

1/Electronically it is a much more robust system due to the simplicity of the circuit. The circuit of the invention is a circuit that controls only the start and stop of the pump while in a frequency variation system the sophistication of the circuit is much greater.

2/ A device with frequency variation needs cooling of the power modules to dissipate the heat generated by them during switching. In the device of the invention it is not necessary because the motor is activated through a relay.

3/ In the device of the invention, electromagnetic interference is not generated as happens in the equipment managed by a frequency converter.

[0051] All these advantages impact a device with:

- Greater robustness
- More compact
- Less maintenance

- Significant reduction of the final costs of the system.

[0052] In this text, the word "comprises" and its variants such as "comprising", etc. They should not be interpreted in an exclusive manner, that is, they do not exclude the possibility that what is described includes other elements, steps, etc.

[0053] On the other hand, the invention is not limited to the specific embodiments that have been described but also encompasses, for example, the variants that can be carried out by the average expert in the field, for example, regarding the choice of materials, dimensions, components, configuration, etc., within what is clear from the claims.

Claims

1. Control device (D) for activation/deactivation of an hydraulic pump and for regulating/adjusting/reducing the output pressure (P_{work}), comprising:

- a housing (H) wherein an inlet (I) of fluid and an outlet (O) are defined;
- an inlet chamber (CI) connected to the inlet (I);
- an outlet chamber (CO) connected to the outlet (O);
- a valve (V1) for reducing the pressure arranged between the inlet chamber (CI) and the outlet chamber (CO) which allows establishing a regulation pressure (P_{work});
- an non-return valve (V2) arranged between the inlet and the inlet chamber (CI);
- a pressure sensor (S1) of the outlet (O);
- a flux sensor (S2) associated to the non-return valve (V2);
- a controller (μ) to which are connected the sensors (S1, S2),

characterised in that the controller (μ) is configured for sending an activation signal (B_{on}) to the hydraulic pump when the pressure sensor (S1) detects the transition of a pressure (P_s) higher than a determined threshold pressure (P_{on}) to a pressure (P_i) lower than the threshold pressure (P_{on}), such that the regulation pressure (P_{work}) is independent from the threshold pressure (P_{on}).

2. Device according to claim 1, wherein the controller (μ) is configured for automatically adjusting the threshold pressure (P_{on}) for activation as a function of a detected working pressure (P_{work}).
3. Device according to claim 2, wherein the automatic adjustment is carried out the first time the device is used, by establishing the threshold pressure (P_{on}) through:

$$P_{on} = P_{work} - \Delta p \quad (I)$$

where Δp is a value stocked in the controller (μ).

4. Device according to claim 2, being the detected working pressure (P_{work}) the pressure detected by the pressure sensor (S1) just after detecting a flux interruption by the flux sensor (S2) after a pump stop.
5. Device according to any of the preceding claims, wherein the controller (μ) is configured for sending an alarm signal and/ or deactivation of the pump if the pressure detected by the pressure sensor (S1) detects the transition to a pressure lower than a determined minimum pressure (P_{al1}) of pressure loss.
6. Device according to any of the preceding claims, wherein the controller (μ) is configured for sending an alarm signal and/ or deactivation of the pump if the pressure detected by the pressure sensor (S1) detects the transition to a pressure higher than a determined maximum pressure (P_{al2}) of excessive pressure in the installation.
7. Device according to any of the preceding claims, wherein the controller (μ) is configured for sending a deactivation signal to the pump it is detected at least a predetermined successive activations number in a predetermined time period, in order to protect the installation in case of accumulation capacity loss thereof.
8. Device according to any of the preceding claims, that does not comprise flux detector arranged between the pressure regulation valve (V1) and the outlet (O).
9. Device (D) according to any of the preceding claims, wherein the regulation valve (V1) comprises a mobile valve body (VM1), a valve seat (VS1), a spring (S) and a regulating screw (TV1) of the force of the spring (S).
10. Device (D) according to any of the preceding claims, wherein the flux sensor (S2) associated to the non-return valve (V2) is composed by a magnet (M1) mounted on the non-return valve (V2) and a detector (DM1) of the magnet (M1) mounted on the controller (μ), being the detector (DM1) preferably a Hall sensor or a Reed Switch.
11. Device (D) according to any of the preceding claims, wherein the inlet (O) and the outlet (S) are arranged in a same axis (Γ).
12. Device (D) according to claim 11, comprising a housing (HE) de the housing (H) arranged opposite the regulation valve (V1) with respect to the axis (Γ), the

controller (μ) being housed in this housing (HE).

13. Device (D) according to any of the preceding claims, wherein the controller (μ) is distributed between a control board (μ 1), and a power board (μ 2) connected therebetween, the control board (μ 1) being provided with the user interface (HMI), the power board (μ 2) being provided with the power electronics components. 5
14. Device according to any of the preceding claims, wherein the pressure sensor (S1) is a pressure transducer. 10
15. Device according to claim 13, wherein the controller (μ) is configured for manually adjusting the threshold pressure (P_{ON}) for activation through the user interface (HMI). 15
16. Device according to any of the preceding claims, comprising a current sensor (DM4) which allows indirectly measuring the power consumed by the pump controlled by the device. 20
17. System comprising at least two pumps (B1, B2) arranged in parallel, comprising a device (D) according to any of claims 1 to 17 common to both pumps and arranged downstream of both, optionally through a collector (COL) arranged between the device (D) and the pumps (B1, B2). 25
30
18. System according to claim 17, wherein the device is configured to alternate the activation of both pumps (B1, B2). 35
19. System comprising at least two pumps (B1, B2) arranged in parallel, each one comprising a device (D1, D2) according to any of claims 1 to 17 arranged downstream, and optionally a collector (COL) arranged downstream of the devices (D1, D2), wherein the devices (D1, D2) are configured and coordinated therebetween such that alternatively one of the pumps (B1, B2) is the first to be started and the second pump (B2, B1) only starts when the other pump (B1, B2) cannot meet the demand. 40
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Fig. 1

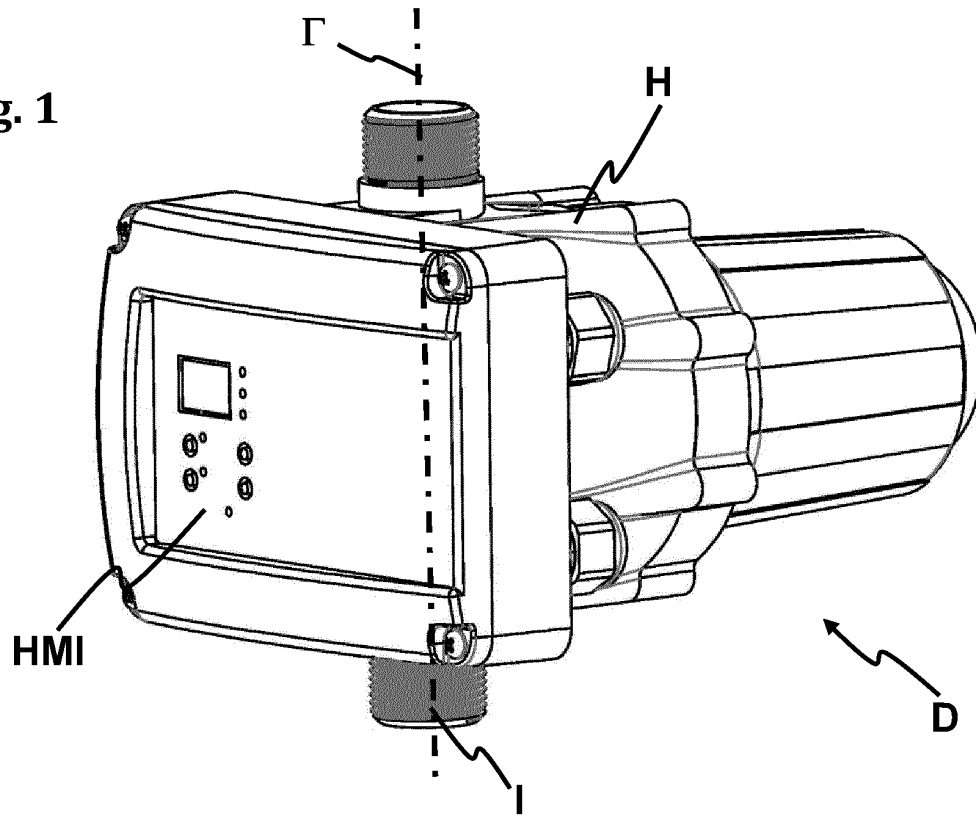


Fig. 2

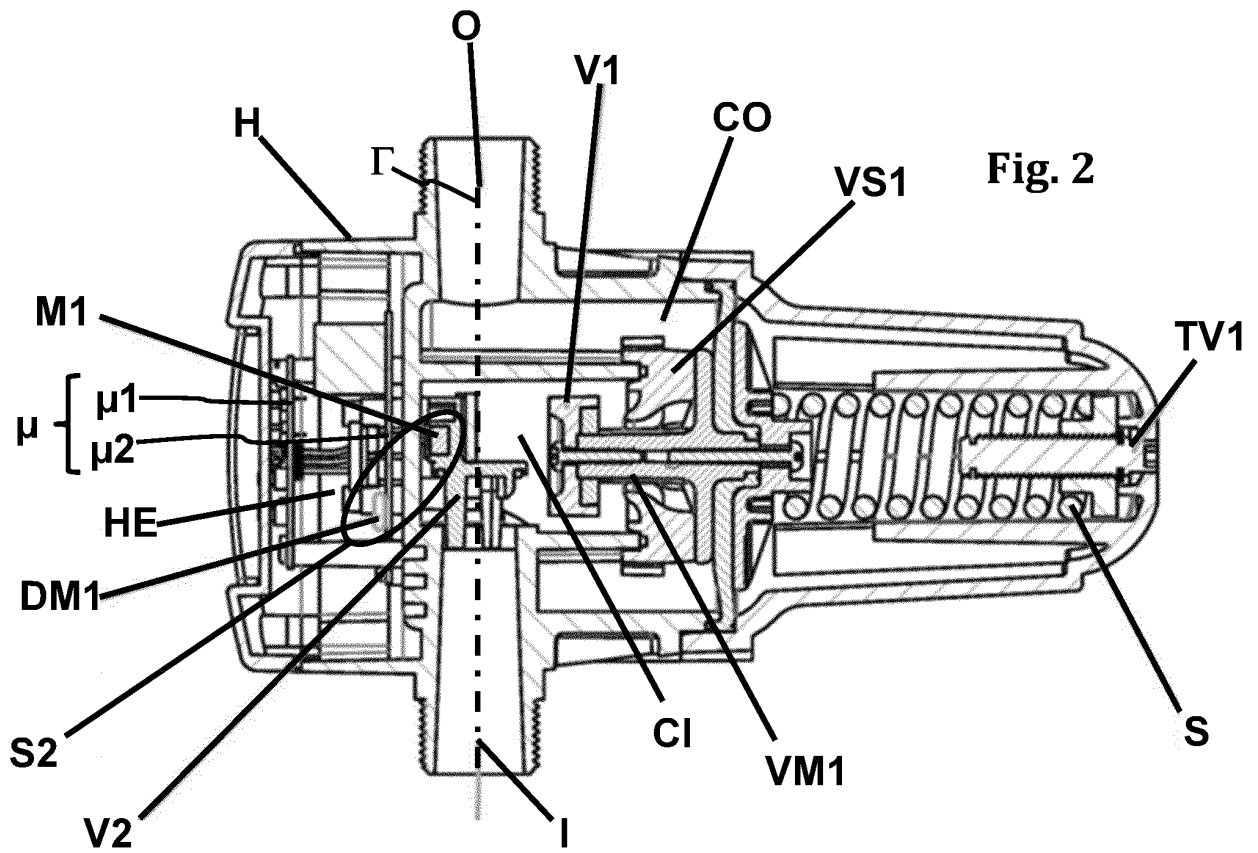
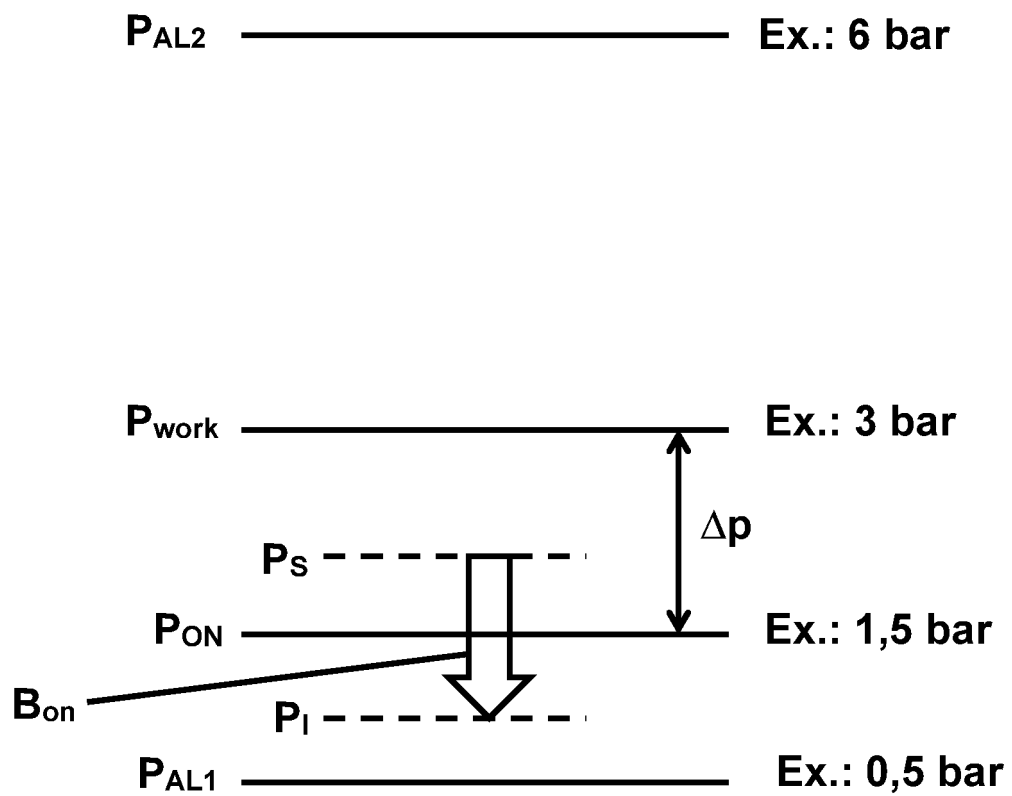


Fig. 3



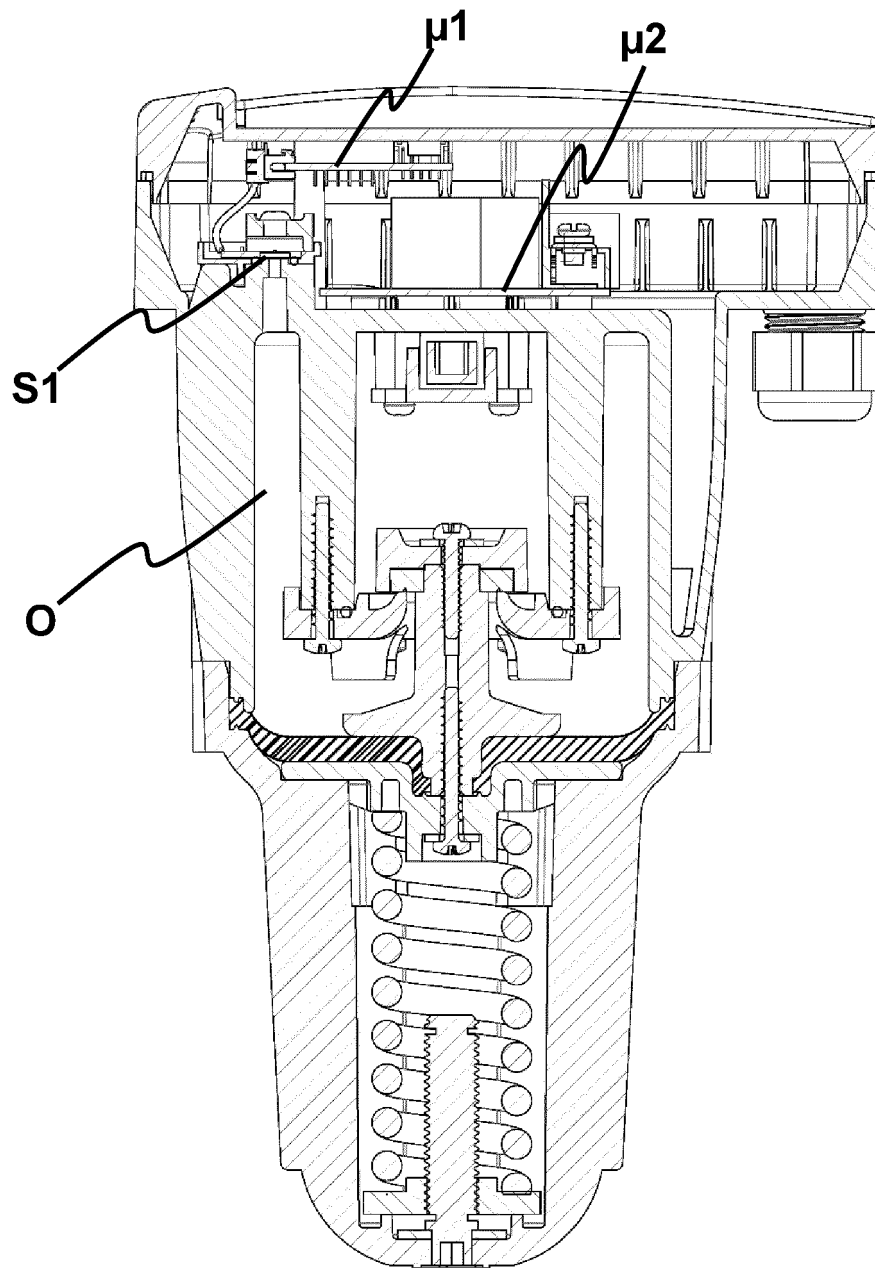


Fig. 4

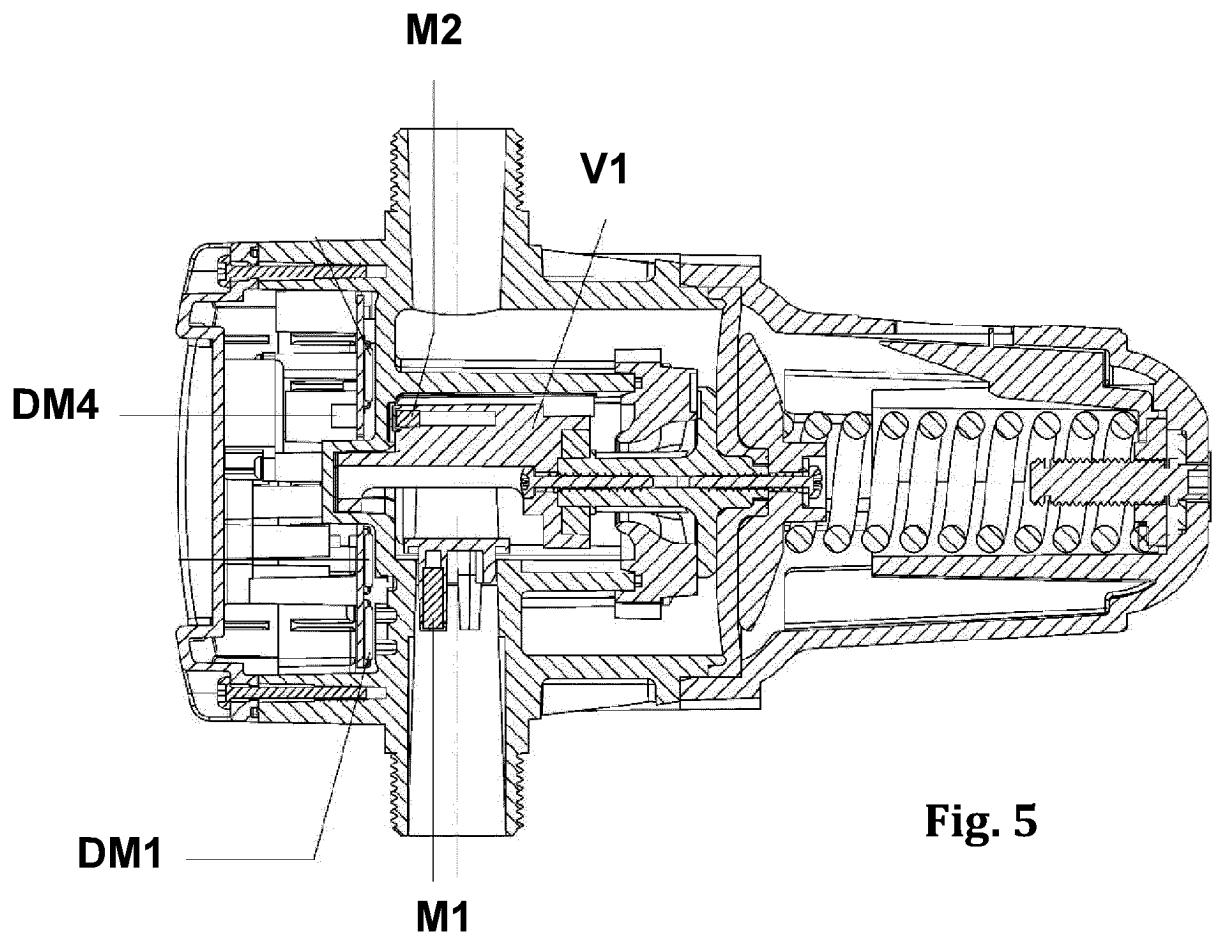


Fig. 5

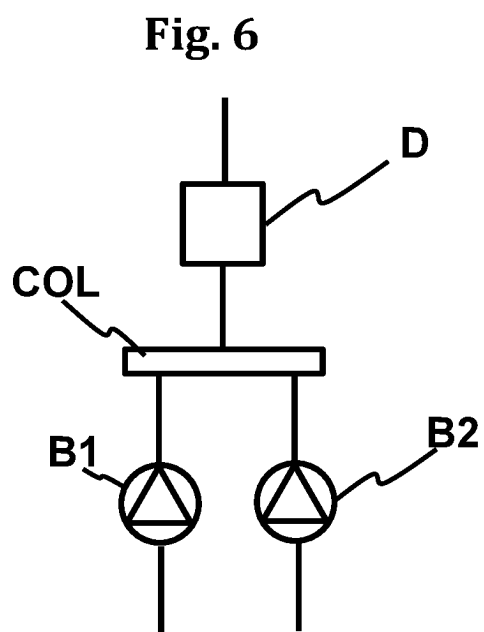


Fig. 6

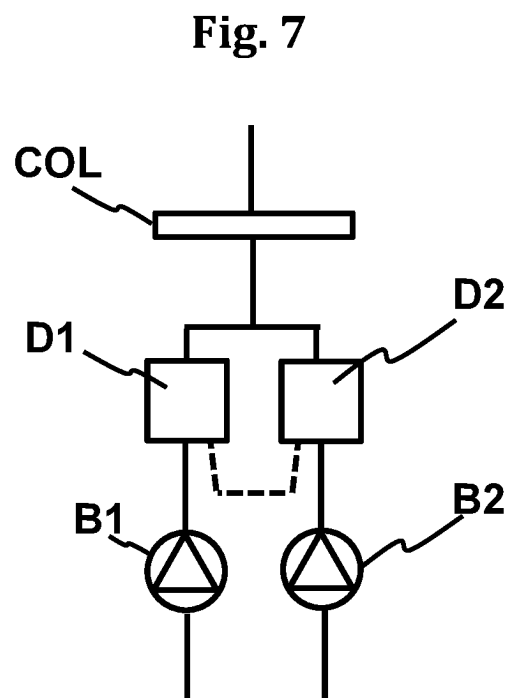


Fig. 7

INTERNATIONAL SEARCH REPORT

International application No.

PCT/ES2022/070182

A. CLASSIFICATION OF SUBJECT MATTER

See extra sheet

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

F04B, F04D

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EPODOC, INVENES

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	WO 03074873 A1 (WATERTECH S P A et al.) 12/09/2003, the whole document	1,2,5,11,12,15
A	WO 2010091454 A1 (DAVEY WATER PTY LTD et al.) 19/08/2010, abstract; page 8, line 26-page 13, line 14; figures 2-8,11	1,9-12
A	ES 2637188 T3 (TREVITECH S R L) 11/10/2017, the whole document	1,10-12
A	WO 2020232508 A1 (WHITE INT PTY LTD) 26/11/2020, paragraphs [0041]-[0053]; figures 3-11	1,9,11,16
A	WO 2018073477 A1 (COELBO CONTROL SYSTEM S L) 26/04/2018, abstract; claim 1; figure 5	19

☐ Further documents are listed in the continuation of Box C.☒ See patent family annex.

* Special categories of cited documents:	"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"A" document defining the general state of the art which is not considered to be of particular relevance.	
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"P" document published prior to the international filing date but later than the priority date claimed	"&" document member of the same patent family

Date of the actual completion of the international search
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(11/07/2022)

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