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(54) Fluid pressure controller for pumps

(57) A device for controlling the operation of pumps in hydraulic circuits by detecting the pressure of the circuit and consequently activating or stopping the pump. The device comprises an oscillating circuit (23), in which the capacitor (17) is a capacitive transducer which cooperates with at least one mechanical actuator (10) for actuating at least one of the plates (15, 18) of the capacitor (17), and means for interfacing with the pump; the actuator (10) is subjected to the pressure of the fluid.

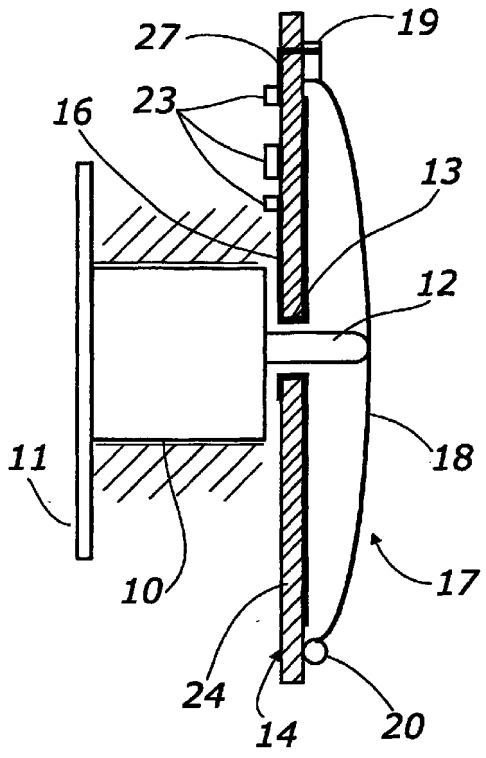

Fig.1

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Description

[0001] The present invention relates to a device for controlling the operation of pumps in hydraulic circuits by detecting the pressure of the circuit and consequently issuing the command to activate or stop the pump.

[0002] Devices which activate and/or stop pumps inserted in hydraulic circuits are already known.

[0003] Among these, mention is made of pressure-controlled switches, which are constituted by a membrane which is loaded by a contrasting spring whose effect is adjustable and actuates switches or microswitches.

[0004] Such devices can be set in the laboratory and according to a single intervention point, i.e., the device activates and deactivates the pump only when the pressure in the circuit is respectively lower or higher than a given preset value, and is also subject to fixed hysteresis effects.

[0005] There are also twin pressure-controlled switches which are constituted by membranes or bellows and contrast springs which are composed of two individually settable microswitches.

[0006] These devices allow to set a different point for starting and stopping the pump, but the intervention point still remains fixed and can be set in the laboratory to preset values for each flow-rate range.

[0007] Another type of device is constituted by an electronic pressure sensor which is constituted by a pressure transducer, usually a piezoresistive silicon diaphragm, which is accommodated within a steel body.

[0008] An elastic membrane is then coupled to the silicon diaphragm by means of an insulating fluid.

[0009] The sensor normally provides a full-scale voltage of 100 mV.

[0010] This voltage is sent to a microcontroller, which is associated with an analog/digital converter which allows to display the value of the detected pressure, expressed in bars, and drives the pump according to a preset program.

[0011] However, even this device is not free from drawbacks.

[0012] These sensors are normally provided with threaded couplings to be coupled to the measurement pipe; accordingly, there is the need for a thread and a sealing gasket.

[0013] The output of the sensor must necessarily be coupled to the electronic circuit by means of cables and a connector; this operation is very delicate, since the sensor and the electronic circuit are located proximate to the pump, which generates electrical-field and magnetic-field noise, and all this also has a negative impact on constructive simplicity.

[0014] It is also indispensable to associate with the controller an analog/digital conversion card in order to convert the 100-mV analog signal into a digital signal which can be processed by the microcontroller.

[0015] Finally, it should be added that this last instrument is very versatile but also has considerable constructive difficulties.

[0016] The aim of the present invention is to provide a device for controlling the operation of pumps in which the drawbacks noted above in conventional devices of this type are eliminated.

[0017] Within the scope of this aim, a consequent primary object is to provide a device for controlling the operation of pumps which is constructively very simple.

[0018] An important object is to provide a device which provides a frequency output and can therefore be easily controlled by a microcontroller without the need for an analog/digital conversion card and with an output signal which is immune to noise and interference.

[0019] Another object is to eliminate the presence of cables and connectors.

[0020] Another object is to provide a device whose operation requires a very small amount of current.

[0021] Another object is to provide a highly compact device.

[0022] Another object is to provide a device which differs from conventional commercially available ones owing to its very low manufacturing and purchase cost.

[0023] This aim, these objects and others are achieved by a device for controlling the operation of pumps, characterized in that it comprises an oscillating circuit in which the capacitor is a capacitive transducer which cooperates with at least one mechanical actuator for actuating at least one of the plates of the capacitor and means for interfacing with the pump, said actuator being subjected to the pressure of the fluid.

[0024] Further characteristics and advantages of the invention will become apparent from the description of an embodiment of the device, illustrated only by way of non-limitative example in the accompanying drawings, wherein:

Figure 1 is a sectional view of the device in an operating position;

Figure 2 is a sectional view of the device in a different operating position;

Figure 3 is a diagram of the electronic system used by the device;

Figure 4 is a block diagram of the operating sequences in which the device is inserted;

Figure 5 is a block diagram of a second operating sequence in which it is possible to use the instrument;

Figure 6 is a functional block diagram of the water head measurement program which is included in the electronic system.

[0025] With particular reference to Figures 1 and 2, a device for controlling the operation of pumps comprises a sensor which is constituted by a piston 10 which cooperates with a sealing membrane 11 which is subjected to the pressure to be detected.

[0026] The piston 10 has a coaxial end protrusion 12 which passes through a hole 13 formed at the center of a support 14 for printed circuits, made of fiberglass-reinforced plastics.

[0027] A rectangular copper surface 15 is provided on said support 14, on the surface that lies opposite the surface 24 that faces the actuator, and is connected to the surface 24 of the support 14 by metallization of the hole 13 and the path 16.

[0028] A film of insulating paint is screen-printed over the rectangular surface 15.

[0029] The rectangular surface 15 constitutes the fixed plate of the capacitor, which is generally designated by the reference numeral 17.

[0030] The movable plate is instead designated by the reference numeral 18 and is constituted by a rectangle of spring steel plate.

[0031] The movable plate 18 is fixed to the support 14 on one side 22 by means of the fixed element 19, which in addition to allowing the flexing of the plate 18 is capable of transferring electrical contact to the opposite surface 24 of the support 14, while the opposite side 21 rests on a guide 20 which allows it to slide on the support 14 but not separate from it.

[0032] When the sealing membrane 11 is actuated by the pressure of the fluid of the hydraulic circuit to which the device is applied, the piston 10 is pushed and the protrusion 12 bends the plate 18 (which assumes the position shown in Figure 2 when at rest), which also constitutes the elastic contrast element for the piston 10.

[0033] The capacitor 17 is part of an oscillating circuit 23, shown schematically in Figure 3, which is directly connected to a microcontroller designated by the same reference numeral.

[0034] The oscillating circuit and the microcontroller form an electronic circuit 23 which is placed on the surface 24 of the support 14.

[0035] The oscillating circuit 23, shown in Figure 3, is constituted by an operational amplifier 26 with a rail-to-rail (inverse feedback) output, which is connected in a classical configuration as an RC oscillator which provides in output a frequency square wave; in said oscillator, the resistors R are designated by the reference numeral 27 and the capacitor C is the variable-capacitance capacitor 17.

[0036] The electronic circuit 23 is connected to the two plates of the capacitor by means of the connections 16 and 27.

[0037] Operation is as follows.

[0038] The device is seated directly in the hydraulic circuit with the sealing membrane 11 in contact with the fluid.

[0039] Stimulated by the pressure of the fluid, the membrane 11 forces a movement of the piston 10, which is contrasted by the elastic plate 18 of the capacitor 17.

[0040] In this manner, the capacitance of the capacitor 17 varies in inverse proportion to the distance between the plates 15 and 18; this variation is detected in output by the oscillating circuit 23, since it provides in output a frequency square wave which is proportional to the value of the capacitance of the system.

[0041] The output of the oscillating circuit is further connected to a microcontroller which, according to a preset program and by cooperating with a driver of the pump, regulates the operation of the pump.

[0042] The results of this regulation are then visualized by means of a visual display (see Figure 4).

[0043] With reference now to Figure 6, the water head measurement program of the device according to the invention provides the following:

a) while the device is not supplied with electric power, the flow of fluid is opened toward the uppermost part of the hydraulic circuit in which the device is installed;

b) the device is then supplied with power and a reset button is operated while a luminous signal (for example a red LED) is on, until said signal starts flashing (this indicates that the measurement step is in progress);

c) the reset button is then released, and this can entail that:

-- the device actuates the pump in order to fill the head of fluid;

-- the device checks that there is a flow of fluid (topmost cock of the system is open and fluid is being drawn); if no fluid is flowing, the luminous signal remains on, the pump stops and remains in this state;

-- when the head is full, the pressure no longer rises and the device switches off the pump, stores the pressure value and, by adding preset fixed values, also stores a minimum pressure value and an intermediate value;

-- the device stops the pump, and after a few seconds the luminous signal stops flashing (for example if an inactive float is detected).

[0044] At the end, normal operation begins.

[0045] The pressure values are:

-- the minimum starting pressure of the pump in case of a slow drop in the pressure;

-- the intermediate pressure in case of detection of lack of fluid while the pump is operating;

-- the pressure of the measurement head while the topmost cock is open and the pump is operating.

[0046] In practice it has been observed that the device thus described achieves the intended aim and all the objects.

[0047] A device has in fact been provided which is constructively very simple and very compact.

[0048] There is no need to use connectors or cables between the sensor and the electronic part, since the sensor is directly integrated in the electronic circuit.

[0049] The system further provides a frequency output, and this entails considerable advantages.

[0050] First of all, it is no longer necessary to use analog/digital conversion cards, since the signal can be read directly by the microcontroller, and moreover the signal has high immunity to noise and interference.

[0051] The system also features a very low current consumption and an extremely low manufacturing cost.

[0052] The invention thus conceived is susceptible of numerous modifications and variations, all of which are within the scope of the inventive concept.

[0053] Thus, for example, with particular reference to Figure 5, the oscillator can be directly connected to a comparator, which refers to a preset intervention value, and to a driver of the pump.

[0054] In practice, the materials used, so long as they are compatible with the contingent use, as well as the dimensions, may be any according to requirements.

[0055] All the details may furthermore be replaced with other technically equivalent elements.

[0056] The disclosures in Italian Patent Application No. PD99A000194, from which this application claims priority, are incorporated herein by reference.

[0057] Where technical features mentioned in any claim are followed by reference signs, those reference signs have been included for the sole purpose of increasing the intelligibility of the claims and accordingly such reference signs do not have any limiting effect on the scope of each element identified by way of example by such reference signs.

Claims

1. A device for controlling the operation of pumps, characterized in that it comprises an oscillating circuit in which the capacitor is a capacitive transducer which cooperates with at least one mechanical actuator for actuating at least one of the plates of the capacitor and means for interfacing with the pump, said actuator being subjected to the pressure of the fluid.

2. The electronic device for controlling the operation of pumps, according to claim 1, characterized in that said capacitive transducer is a planar capacitor.

3. The electronic device for controlling the operation of pumps according to claim 1, characterized in that said mechanical actuator is a cylindrical piston arranged at right angles to the capacitor.

4. The electronic device for controlling the operation of pumps, according to claim 1, characterized in that said means for interfacing with the pump are a microcontroller and a driver of the pump.

5. The electronic device for controlling the operation of pumps according to claim 1, characterized in that said means for interfacing with the pump are a comparator and a driver of the pump.

6. The electronic device for controlling the operation of pumps according to claim 1, characterized in that said oscillating circuit is constituted by an operational amplifier with rail-to-rail (negative feedback) output connected in a classical configuration as an RC oscillator.

7. The electronic device for controlling the operation of pumps according to claims 2 and 3, characterized in that said planar capacitor has a fixed plate and a movable plate which cooperates with the cylindrical piston.

8. The electronic device for controlling the operation of pumps according to claim 3, characterized in that said cylindrical piston cooperates, by means of the end that lies opposite the one that cooperates with the movable plate of the capacitor, with a sealing membrane which is arranged in contact with the fluid.

9. The electronic device for controlling the operation of pumps according to claim 7, characterized in that said fixed plate of the capacitor is made of copper and is provided on a support for printed circuits made of fiberglass-reinforced plastics.

10. The electronic device for controlling the operation of pumps according to claims 7 and 9, characterized in that said fixed plate of the capacitor has a central through hole for the passage of an end of the cylindrical piston.

11. The electronic device for controlling the operation of pumps according to claim 7, characterized in that said movable plate is constituted by a rectangle of spring steel plate and is fixed to the fiberglass-reinforced plastic support on one side by means of a fixed flexing element for transferring the electrical contact to the opposite surface of the support, while the opposite side rests on a flexing and translatory motion guide.

12. The electronic device for controlling the operation of pumps according to claims 4 and 6, characterized in that said oscillating circuit and said microcontroller are mounted directly on the fiberglass-reinforced plastic support.

13. The electronic device for controlling the operation of pumps according to claim 12, characterized in that

said oscillating circuit and said microcontroller are mounted on the fiberglass-reinforced plastic support on the opposite face with respect to the one where the fixed plate of the capacitor is fitted.

14. The electronic device for controlling the operation of pumps according to one or more of the preceding claims, characterized in that a film of insulating paint is screen-printed onto the fixed plate of the capacitor.

15. The electronic device for controlling the operation of pumps according to one or more of the preceding claims, characterized in that in order to measure the water head:

while the device is not supplied with electric power, the flow of fluid is opened toward the uppermost part of the hydraulic circuit in which the device is installed;
the device is then supplied with power and a reset button is operated while a luminous signal is on, until said signal starts flashing (this indicates that the measurement step is in progress);
the reset button is then released, and this can entail that:

-- the pump is operated in order to fill the head of fluid;
-- the device checks that there is a flow of fluid (topmost cock of the system is open and fluid is being drawn); if no fluid is flowing, the luminous signal remains on, the pump stops and remains in this state;
-- when the head is full and the pressure no longer rises, the device switches off the pump, stores the pressure value and, by adding preset fixed values, also stores a minimum pressure value and at least one intermediate value;
-- the device stops the pump, and after a few seconds said luminous signal stops flashing (for example if an inactive float is detected);
-- at the end, normal operation begins.

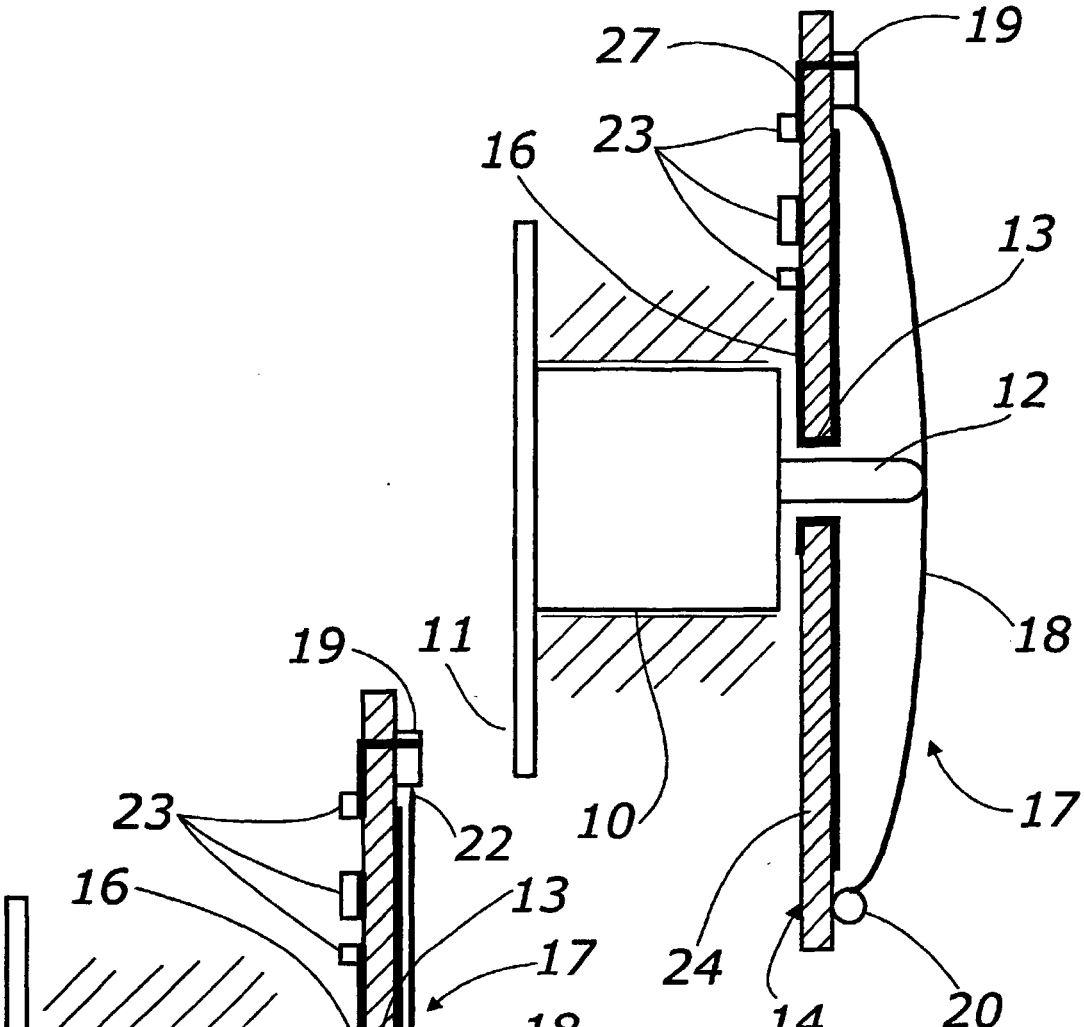
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Fig.1

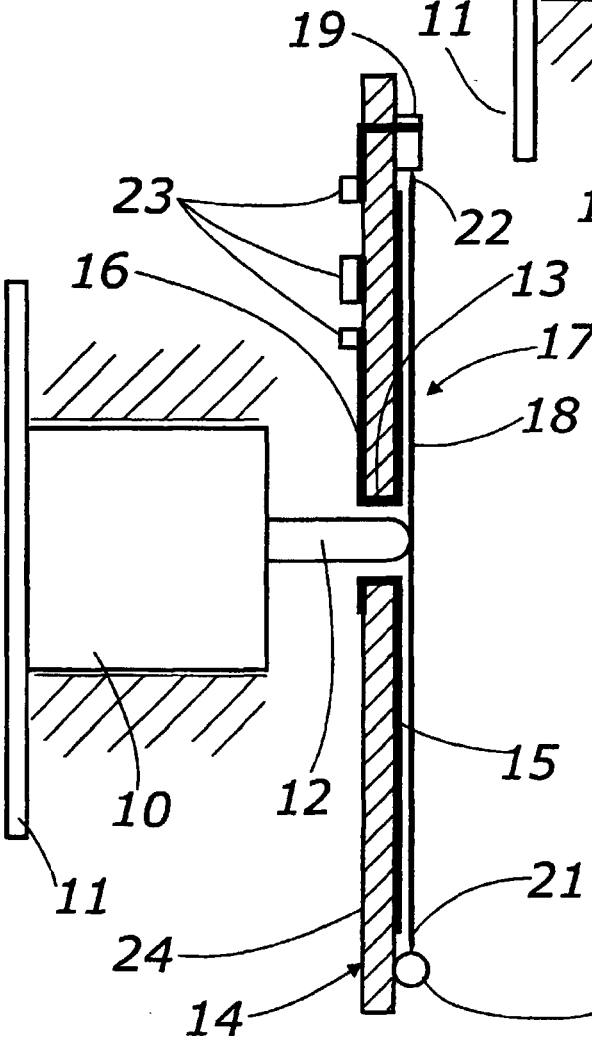
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Fig.2

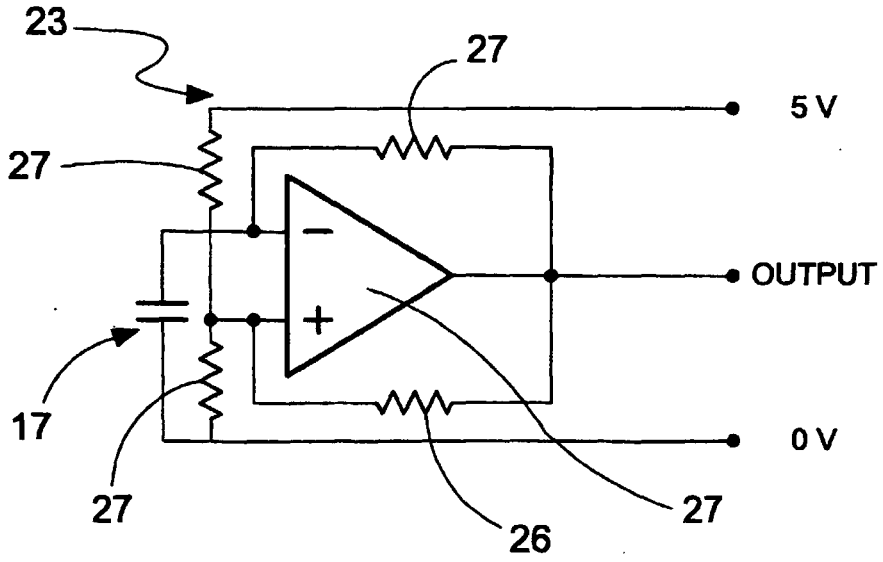

FIG. 3

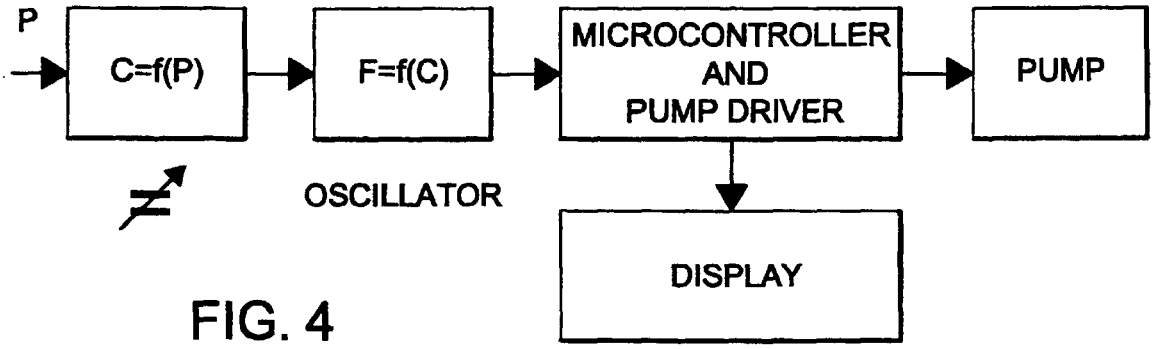

FIG. 4

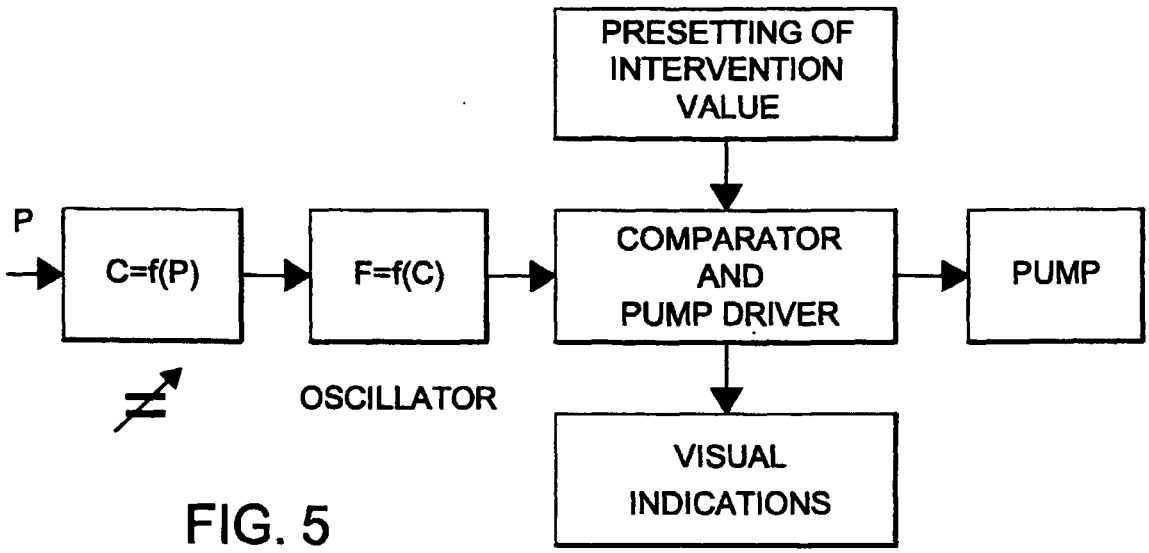

FIG. 5

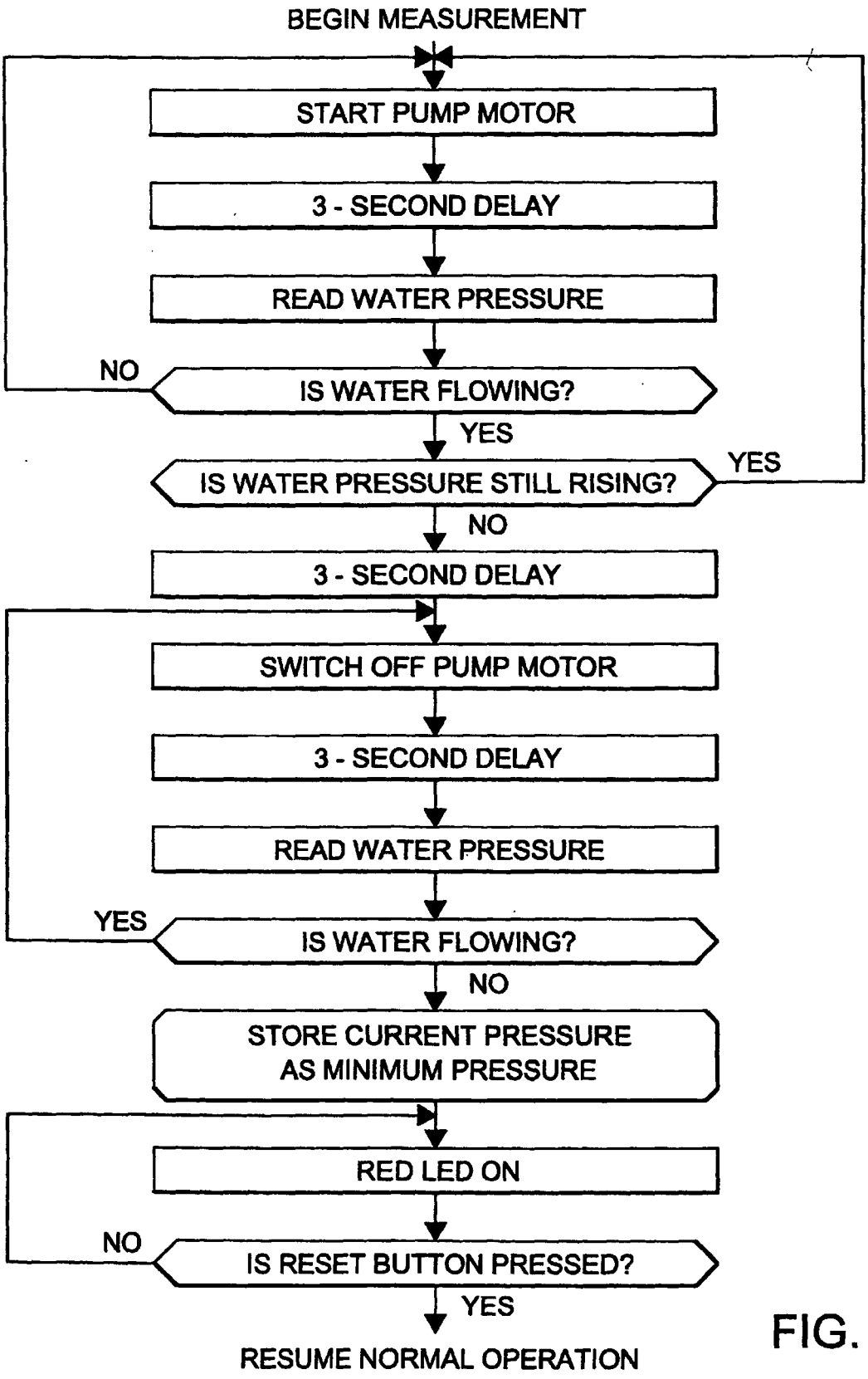
BEGIN MEASUREMENT
START PUMP MOTOR
3 - SECOND DELAY
READ WATER PRESSURE
NO
IS WATER FLOWING?
YES
YES
IS WATER PRESSURE STILL RISING?
NO
3 - SECOND DELAY
SWITCH OFF PUMP MOTOR
3 - SECOND DELAY
READ WATER PRESSURE
YES
IS WATER FLOWING?
NO
STORE CURRENT PRESSURE
AS MINIMUM PRESSURE
RED LED ON
NO
IS RESET BUTTON PRESSED?
YES
RESUME NORMAL OPERATION

FIG. 6