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A Manufacturing Invention for the Water-pressure Stabilizer Control System[1]

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Abstract: - In this paper, we create an invention. The invention relates to a kind of Water-pressure Stabilizer Control System. It includes i. pump; ii. pressure sensor; iii. feedback controller； iv. Proportional Integral Derivative Controller (PID); v. frequency transformer. The performance of the new invention are attractive through the simulation of the application example.

Key-Words: - PID Controller, water-pressure, frequency transformer, pressure sensor, feedback controller

1 Introduction

The object of this paper is to create an invention. The invention relates to a water-pressure stabilizer control system. It specifically relates to a water-pressure stabilizer control system that mainly owns the Micro Chip Proportional-Integral-Derivative (MCPID) Controller. The advantage of the functions of this invention are: space saving and efficiency increase.

Generally, the water-pressure of the faucet varies all the time. For those users who live in the high buildings encounter these situations often. There are many papers have mentioned about how to control the water-pressure to a steady value [1]-[14]. But few paper mentioned about the liquid stabilizer controller. In [15], we submit a rough idea in designing the liquid stabilizer controller, but the low rate of the liquid stabilizer controller occurs. The common stabilizer pressure method is to construct the water tower or to use the big pressure pump. But these two methods occupy much space and the water-pressure varies from the number changing of the users. If there is a user who requires stable pressure value (such as high-tech company), the quality control issues occur. Some of the factories (such as the Block Factory) have to use the water or other liquid on the production line. The more stable of the water- pressure, the better quality of their products. Especially the High-Tech IC companies use the special liquid to cool their products, the 'stabilizer controller' would be a good application. Besides that, the hot water pipe of the bathroom and the kitchen is always the same one. The water-pressure decrease while many people use the water at the same time. The hot water varies from high heat to low heat in the bathroom. And those people who are doing the dishes lack water at that time. The definition of taking a bath is not only cleaning the body only at present time. It becomes an enjoyment. The commercial ad talks about the stabilizer hot water equipment, but this equipment needs enough and steady water supply or the functions will not work at all.

Therefore, we design a device that owns the water-pressure stabilizer control function. Comparing with the water tower and pump, our device requires less space and controls the water-pressure output at a stabilizing value no matter the variation of the users.

We organize our paper in the following manner. The invention content of the Water-pressure Stabilizer Control System is presented in Section 2. Then the implementation methods are listed in Section 3. Finally, we make a brief conclusion in Section 4.

2 Invention Content

The purpose of this manufacturing invention is to provide a Water-Pressure Stabilizer Control System. It uses the Micro-Chip controller to control pump compress/decompress the water pressure in the

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penstock. This invention not only reduces the space but also decreases the maintenance cost.

In order to reach the purpose of this invention, we provide a Water-pressure Stabilizer Control System. It includes i. pump: is used to connect with the watering system and to compress/decompress the water-pressure in the penstock; ii. pressure sensor: is installed in the penstock and used to detect the water-pressure of the penstock and used to produce the pressure detecting value responding to the water-pressure; iii. feedback controller: is used in analog/digital transformation, it stores and calculate the pressure sensor value to create the feedback signal； iv. Proportional Integral Derivative (PID) Controller: is used to receive the feedback signal and to produce the control signal; v. frequency transformer: is used to speed/slow the pump on the base of the control signal output frequency signal, while the pressure sensor value of the water-pressure is equal to the prior set value of the water-pressure, the frequency conversion signal would make the pump operating stably or stop operating.

Furthermore, based on the prior view points, the pressure sensor is installed inside the penstock or at the outlet. Based on these points, the pump is the type of under-water pump or siphon pump.

Combining with figures, the characteristics and advantages of this invention will be cleared described in the following sections. It should be noticed that the same units are represented with the same symbols.

3 Implementation Method

The detailed implementation description of this manufacturing invention is presented in this section. The block diagram of this manufacturing invention is represented in Fig. 1.

In Fig. 1, #1 points out the invention---Water-pressure Stabilizer Control System;

#2 denotes the 'Motor' including a pump, the pump is connected with a penstock that is a water supplying system. This pump is used to compress/decompress the water-pressure in the penstock and stabilizes the water-pressure with a pre-set water-pressure value;

#3 denotes the 'Pressure sensor' is stored in the penstock, is used to detect the water-pressure in the penstock, and to calculate the pressure sensor value that is responding to the water-pressure;

#4 denotes the 'Feedback controller', is used to transform the analog value of the pressure sensor value exported from pressure sensor 3 to the digital value. And this digital value is stored in the buffer of the feedback controller. The feedback controller also calculates the average of the multiple pressure values and creates a feedback signal;

#5, PID Controller (Proportional-Integral-Derivative Controller), is used to receive the feedback signal and create control signal;

#6 denotes the 'Frequency transformer', is used to speed/slow the pump (inside #2) on the basis of the export frequency signal of the control signal. While the pressure sensor value of the water-pressure is equal to the predicted water-pressure value. The frequency signal would make the pump (inside #2) stabilizing operating or stop operating.

In the following, we make a reference at Fig. 2, Fig. 3A, Fig. 3B, and Fig. 3C to draw the hardware structure in Fig. 1 and its main items connection relationship diagram. The #3, 'Pressure sensor', is installed inside the penstock. The #3, 'Pressure sensor', can detect the pressure sensor value of the water-pressure inside the penstock. The #3, 'Pressure sensor', exports the electric current value that is responding to the sensor value of the water-pressure, such as between 0 (mA) to 4 (mA). We can realize from the former section, the quantities of #3, 'Pressure sensor', are not limited and are installed in every areas of the penstock while necessary. Such as, we can serially install or parallel install multiple pressure sensors at each floor, each area, each outlet of the buildings.

The #4, 'Feedback controller', is used to collect the electric current value of the #3, 'Pressure sensor', from each area. The #4 uses the analog/digital converter (ADC) to transform the electric current to digital pressure value and stores the digital pressure value in the buffer of the #4 (feedback controller). Then, we use the micro-chip to calculate the multiple pressure values those are created at a period time and obtain an average value. And the feedback signal is created and transferred to the next stage #5, 'PID'.

In the following, we make a clear introduction about the design rule and operation of #5, MCPID, and #6, 'Frequency transformer'.

First, we describe the design rule of #5, MCPID. The #5, MCPID (Micro-Chip Proportional-Integral-Derivative controller), is called 'Three-mode controller', too. It can be stated as

$$u(t) = K_P e(t) + K_P K_I \int_o^t e(\tau) d\tau + K_P K_D \frac{de(t)}{dt}.$$

The part of the Proportional Controller is $u(t) = K_P e(t)$, it uses the fast speed to main the system work;

The part of the Integral Controller is $u(t) = K_P e(t) + K_P K_I \int_o^t e(\tau) d\tau$, it raises the stabilizing accuracy of the system;

The part of the Derivative Controller is $u(t) = K_P e(t) + K_P K_D \frac{de(t)}{dt}$, it owns the function of pre-correcting error signal. It represents validity in controlling the sudden change while the overloading of the procedures.

And the control action also appears advantages while assembling the *P* (Proportional), *I* (Integral), *D* (Derivative) controller. This assembling can efficiently stabilize the system.

Second, we describe the operation of MCPID, Controller #5, and Frequency Controller, #6 in the following:

i. While MCPID Controller, #5 receive the feedback signal of the form $|P_s\text{-}P_{rav.}|>C$ (it represent the real-time water-pressure is very low), then the MCPID Controller output the S_h control signal to the frequency transformer, #6. While the frequency transformer, #6 receives the S_h control signal, it output the higher frequency signal f_h to drive the Motor pump, #2 speed the degree of pressure.

ii. While the MCPID Controller, #5 receives the feedback signal of the $\varepsilon<|P_s\text{-}P_{rav.}|\leq C$ (it represents the real-time water-pressure increases but still low), then the MCPID Controller output the S_l control signal to the frequency transformer, #6. While the frequency transformer #6 receives the S_l control signal, it output the lower frequency signal f_l to drive the pump #2 to increase the pressure.

iii. While the MCPID Controller #5 receive the feedback signal of the $|P_s\text{-}P_{rav.}|\leq\varepsilon$ (it represents the real-time water-pressures reaches the steady status), then the MCPID Controller exports the S_s steady output signal to the frequency transformer, #6. While frequency transformer, #6 receives the S_s steady control signal, it output the steady frequency signal f_S to drive pump #2 to stabilizing operating or stop operating. The notation is described in the following:

P_s: denotes the pre-set water-pressure value.

$P_{rav.}$: denotes the average value of sensor pressure.

S_h, S_l, S_s: denote the output signal of MCPID controller #5.

f_h, f_l, f_s: denote the output signal of frequency to the Frequency Transforms #6.

C: denotes the assumed value of pressure difference value.

ε: denotes a small positive pressure value.

4 Conclusion

We use the MCPID base to design a Water-pressure Stabilizer Control System. Combining with the theory, practical application and simulation test, our invention can efficiently stablize the water pressure in the building and the factory. The invention appears a high commercial economy value.

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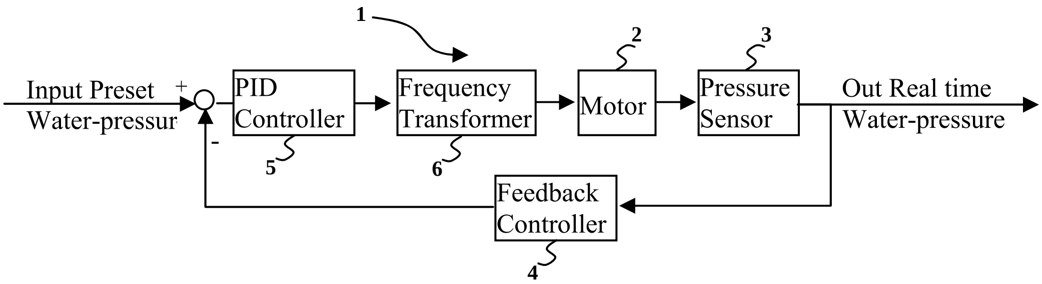

Fig. 1 The block diagram of Water-pressure Stabilizer Control System

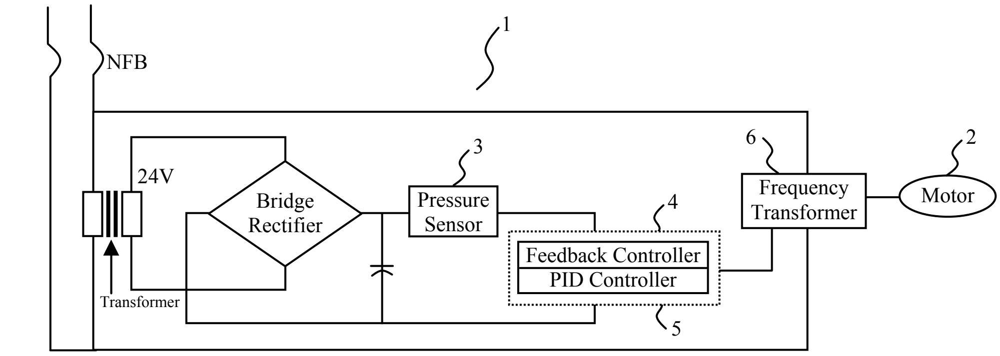

Fig. 2 The hardware structure of water-pressure stabilizer control system

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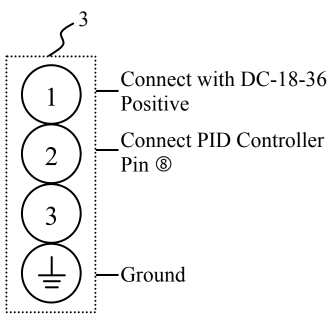

Fig. 3A The connection of the elements of #3 Pressure Sensor

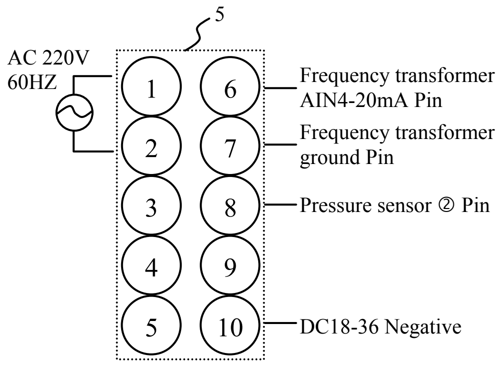

Fig. 3B The connection of the elements of #5 PID Controller

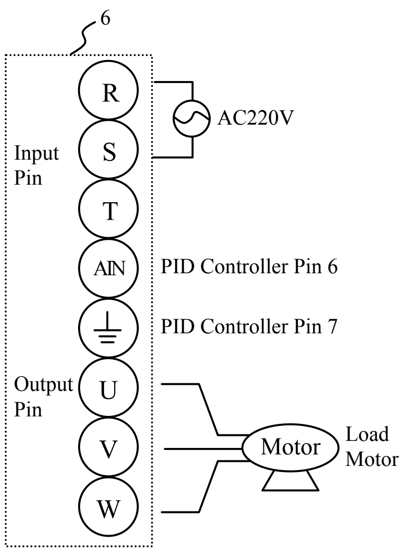

Fig. 3C The connection of the elements of #6 Frequency Transformer

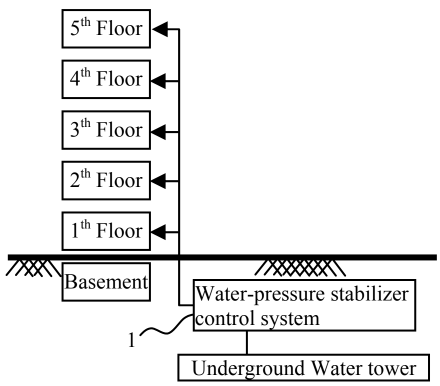

Fig. 4 An application example of the invention of Water-pressure Stabilizer Control System