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Water Pressure Switch Design Using 555 Timer

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تصميم مفتاح ضغط الماء باستخدام مؤقت 555

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Abstract:
For industrial processes to be done properly, a system has to work under specific pressures. Safety considerations as well demand monitoring and “measuring” operation pressures and taking control over them to therefore ensure the equipments and lines in the systems don't exceed the permissible pressure as well as to ensure they are not destroyed or damaged in case the pressure is increased over a certain limit. These objectives can be attained by using sensors and pressure switches which are considered from the most important components in the industrial processes, specifically in the hydraulic and aerial systems.
This project is set for designing and constructing an automatic pressure switch for a pressure source (pump), to automatically control water pressure which happens as a result of its influx in the hydraulic systems. Taking control over this process is done by using (SR flip flop) which receives a controlling signal from the (limit switch). The latter could sense the movement of the used pressure sensor. After that, a model is applied for a domestic water pump to control its operation. The model could protect the pressure when it increases over a certain limit, the flip-flop stops operating the source of the pressure (the pressure). At that, the model has been put into test and the results were very good as expected.

Keywords: electronic pressure switch, 555 timer, SR flip flop.

الملخص
لكي تتم العمليات الصناعية بشكل صحيح، يجب أن يعمل النظام تحت ضغوط محددة كاعتبارات السلامة ومراقبة وقياس ضغوط التشغيل، والسيطرة عليها بما يضمن عدم تجاوز المعدات والخطوط في الأنظمة الضغط المسموح به وكذلك لضمان عدم تدميرها أو تلفها في حالة زيادة الضغط على مستوى معين .
هذه الأهداف يمكن تحقيقها باستخدام أجهزة الاستشعار ومفاتيح الضغط التي تعتبر من أهم المكونات في العمليات الصناعية، خصوصًا في الأنظمة الهيدروليكية أو الهوائية.
تم اعداد هذا المشروع لتصميم وبناء مفتاح ضغط أوتوماتيكي لمصدر الضغط (المضخة)، للتحكم التلقائي في ضغط الماء الذي يحدث نتيجة لتدفقه في الأنظمة المائية، حيث يتم التحكم في هذه العملية باستخدام (SR flip flop) الذي يتلقى إشارة تحكم من (limit switch) ويمكن لهذه الأخيرة استشعار حركة حساس الضغط المستخدم. بعد ذلك، يتم تطبيق نموذج مضخة مياه للتحكم في تشغيله ويمكن أن يحمي النموذج الضغط عندما يتجاوز الحد المحدد، (flip flop)) ويتوقف عن تشغيل مصدر الضغط، وقد تم اختبار هذا النموذج فكانت النتائج جيدة كما هو متوقع.
الكلمات المفتاحية: مفتاح ضغط إلكتروني، مؤقت 555، دائرة التأخير.

1. Introduction

The electronic pressure switch is a form of switches that just opens or closes an electrical contact when a certain set fluid pressure has been reached on its input. The switch may be designed to make contact either on pressure rise or on pressure fall. Pressure switches are widely used in industry to automatically supervise and control systems that use pressurized fluids [5]. .The electronic pressure switch usually consist of two parts: The first converts pressure to a force or displacement, and the second converts the force or displacement to an electrical ON/OFF signal. Pressure switches are made only for gases and liquids. First in1594 Galileo Galilei from (Italy), obtains the patent for a machine to pump water from a river for the irrigation of land. The heart of the pump was a syringe he found that 10 meters was the limit to which the water would rise in the suction pump, but had no explanation for this phenomenon. Scientists were then devoted to find the cause for this. switches are usually operated on manually or on automatic modes [1,4]. The output in both cases is essentially digital in nature either ON or OFF depending on the change in its input. When talking on the automatic switch, the thinking is goes on using a sensor element to produce the suitable force that used to change the state of the switch between ON and OFF. On other hand, the small change in the sensor reading around the switching value (troubleshoot) alternate the switch between the two states. This concept is best demonstrated in an example .Figure 1 shows the pressure comparator switch [2].

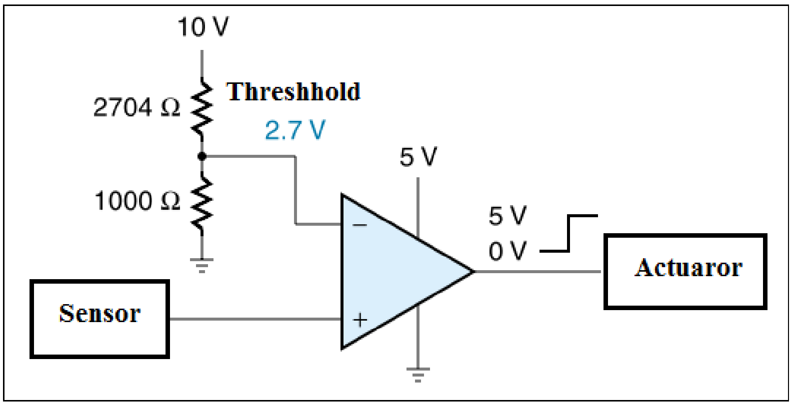

Figure 1: Comparator switch.

The signal from the sensor is connected to the non-inverting input of the comparator. The inverting input comes from a voltage divider that yields a precise reference voltage of 2.7 V. Notice also that the supply voltages of the comparator are 5 V and ground. As long as the sensor voltage is below 2.7 V, the reference voltage at the inverting input predominates, and the output will try to go negative. In this case, the output will go to about 0 V because that is what the negative supply voltage is. When the sensor voltage goes only slightly above 2.7 V, the non-inverting input becomes positive compared with the inverting input, and the output saturates positive, which is about 5 V. The switch-on point can easily be adjusted by changing the reference voltage resistors [1].

Material and methods

In the beginning, the first thinking to design the desired pressure switch is focused on switching the pump directly by normally open limit switch as shown in Figure 2

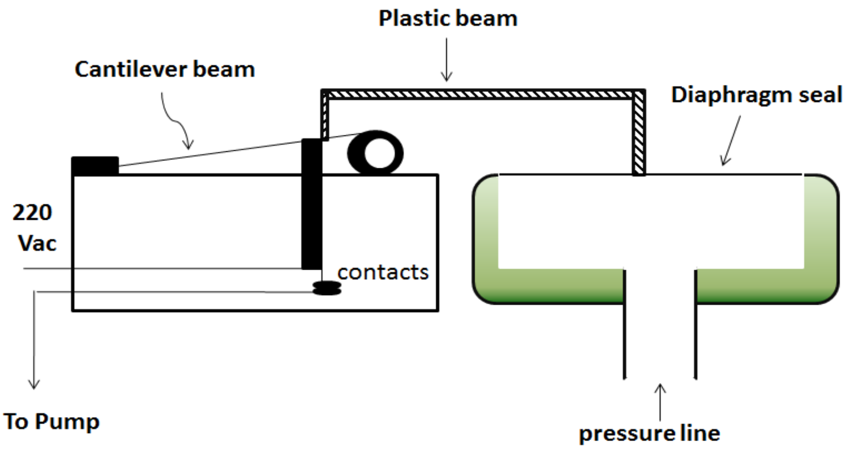

Figure 2: pressure switch with limit switch and diaphragm seal.

The suggested block diagram of the designed switch is illustrated as in figure 3

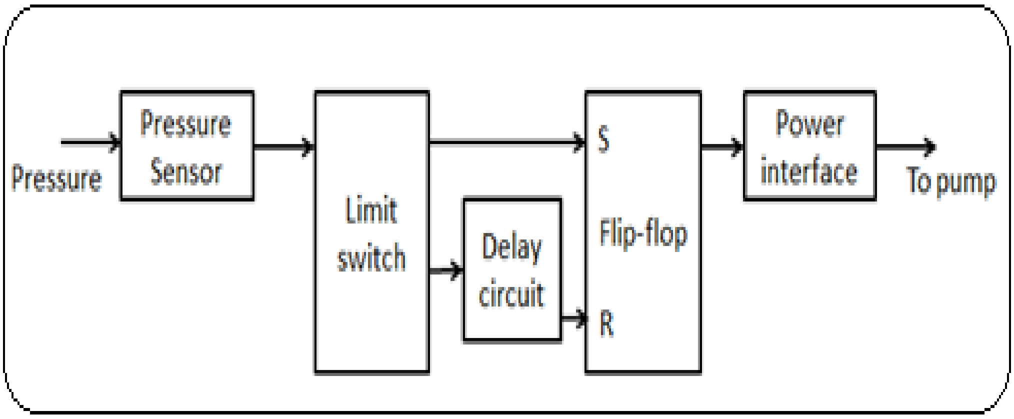

Figure 3: The suggested pressure switch components.

Design clock source circuit

This circuit is needed as the clock source for S R flip-flop. The designed circuit uses the IC 555 timer in an astable operating mode which generates a continuous output via Pin 3 in the form of a square wave. The speed of the signal is set by the values of C1, R1 and R2.

The following elements are used to design the clock source: [3,6]

Resistor 1K Ω , resistor 14.7K Ω , capacitor 22µF , capacitor 10nF , Timer 555, Test board .

The calculation of the time intervals can be done by selecting the values of R1=1K Ω, R2=14.7K Ω and C1=22µF:

T_(h=) 0.693(R_1+R_(2)) C_1

T_(h=) 0.693(1000+14700)22* 〖10〗 ^(-6)

T_(h=) 0.2393s=239.3ms

T_(l=) 0.693(R_2)C_1

T_(l=) 0.693(14700)22* 〖10〗 ^(-6)

T_(l=) 0.2241s =224.1ms

Now, may be test the designed circuit by using a Multisim program as shown in Figure 4below:

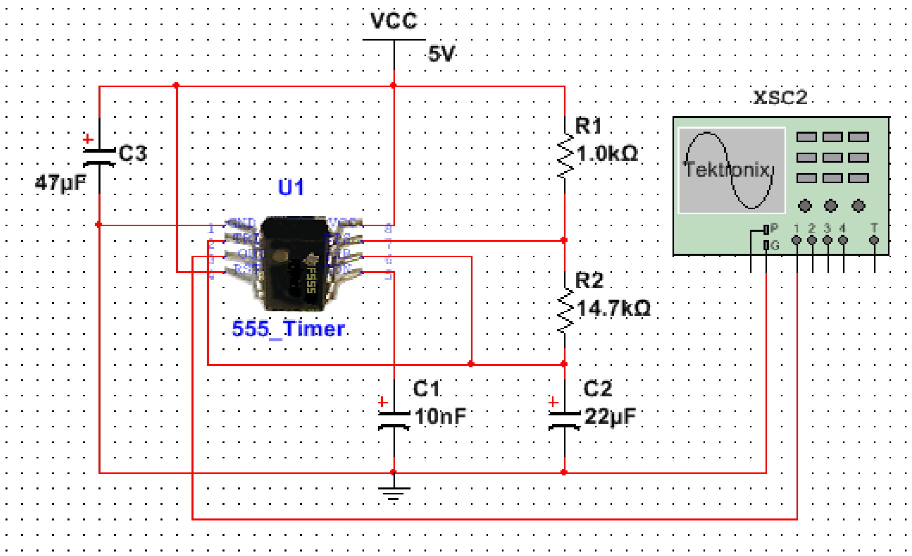

Figure 4: Testing the clock circuit in Multisim program.

The results of the circuit are appeared in Figure 5.

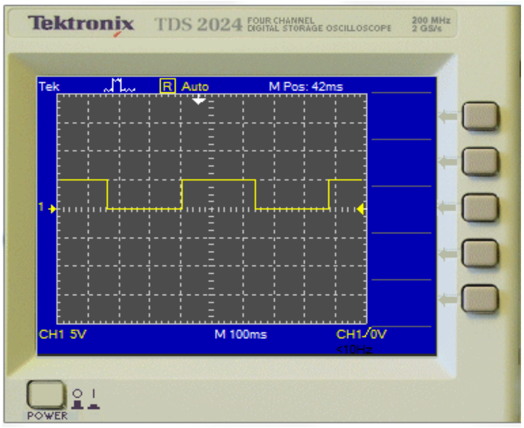

Figure 5: Output signal of the clock circuit in Multisim program.

Design flip-flop circuit
The circuit is designed via two (AND) gates, two (NOR) gates and a clock source (CLK). it was making a test of circuit in computer software using Multisim program, as shown in Figure 6below:

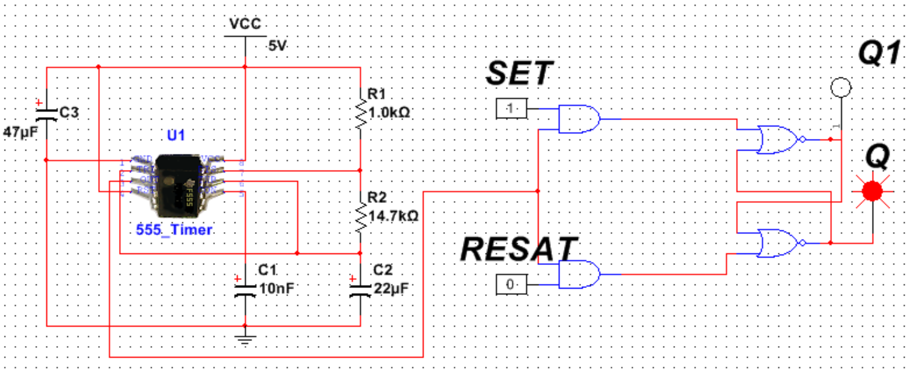

Figure 6: Testing the flip flop circuit in Multisim program

Design a pre- logical control for S R flip- flop
In the SR flip-flop, both the SET and RESET inputs shouldn't be HIGH when the clock is triggered. This situation is considered an invalid input condition, and the resulting output isn't predictable if this condition occurs.In short, it won't work. and to avoid the stats of set, reset are bout low 0V, because this stat gives No change of the output and this effect on our circuit.
So we added an one AND gate, tow NOT gate in the system to avoid the active HIGH in both inputs or active LOW in the same time ,in the figure 7shows the logic control in our system.

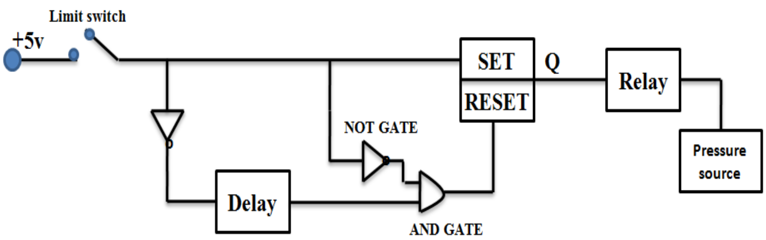

Figure 7: pre- logic control in the system.

Design delay time circuit
In this circuit we using IC 555 timer chip in monostable mode. This circuit is activated by a signal that come from the limit switch. After the calculated delay time, the output goes high. The time delay will be adjusted via the values of the resistor R and capacitor C, the main function of this circuit is to reset the S R flip flop after the time finish which is the main solution of the chatter problem.

From the monostable mode of timer 555 principal work and the equation T=1.1×R×C, we chosen the fallowing values for the circuit:
resistor 187K Ω, capacitor 100μF, capacitor 10nF, Timer 555.
The time interval for a 555 monostable circuit is a measure of how long the output to active high when it's triggered. To calculate the time interval, use this formula:
$T = 1.1 \times R \times C$
Where,
T is the time interval in seconds.
R is the resistance of R1 in ohms.
C is the capacitance of C1 in farads.
If we chose R is 187kΩ, and C is 100μF, the calculate the time interval like this:
$T = 1.1 \times 187000\Omega \times 0.0001\ F$
$T = 20.5\ s$
The circuit active high after20.5 seconds after it's triggered from the limit switch.

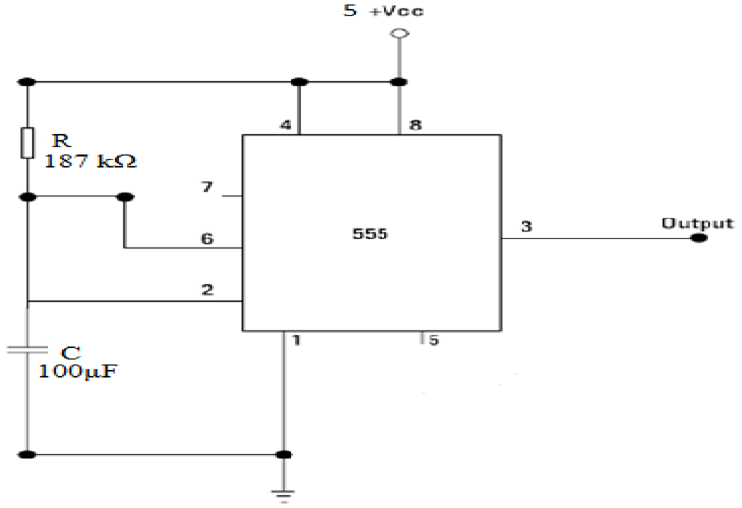

Figure 8: Schematic diagram of the delay time circuit.

it was making a test of delay time circuit in computer software using Multisim program, as shown in Figure 9 below, The output active high after 20.1s.

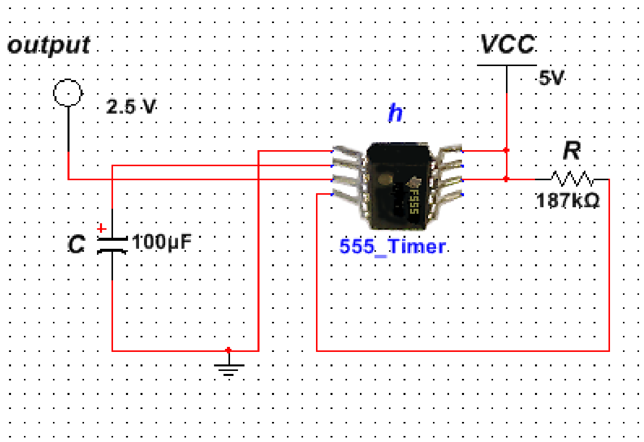

Figure 9: Testing the delay time circuit in Multisim program.

Overall system implementation and operation
The final form of the electronic pressure switch can be implemented according to the overall system block diagram showed in the Figure 4, and a pre-logical controller as showed in Figure 7. It was making a test of overall circuit in computer software using Multisim program, as shown in Figure 8below:

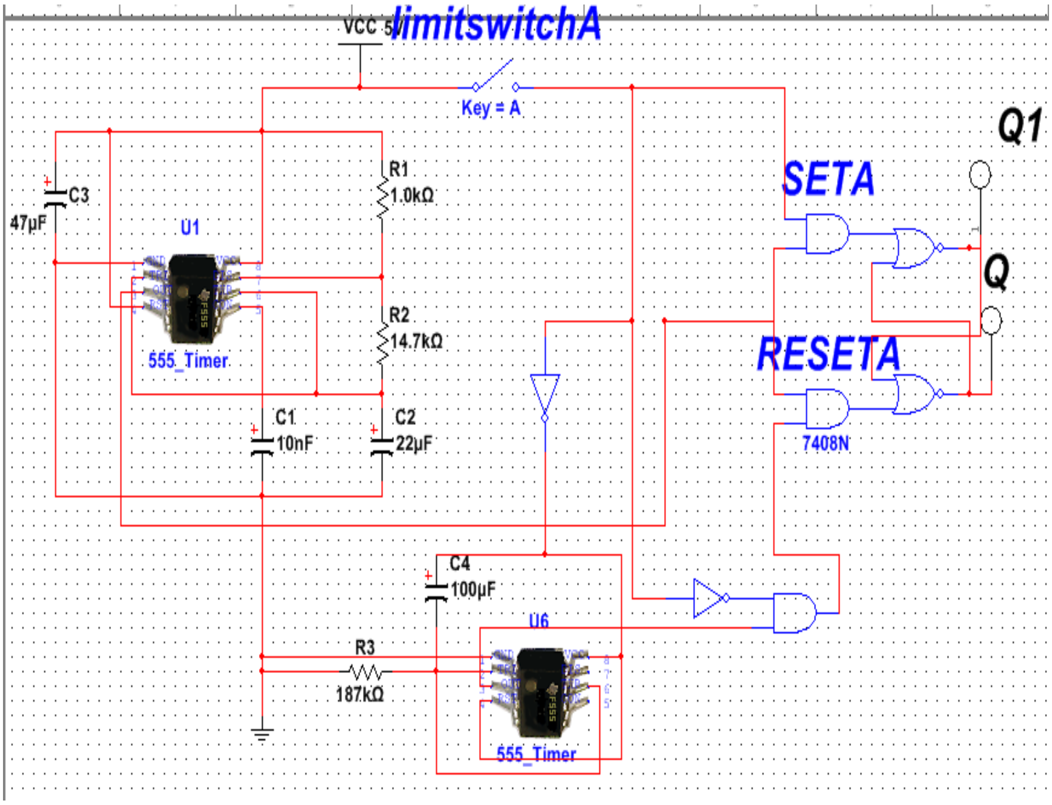

Figure 10: Testing the overall circuit in Multisim program.

After the circuit tested; this circuit can be implemented in a real board as shown in Figure 11below. The overall system is powered using two sources which are 5V DC and 220VAC.

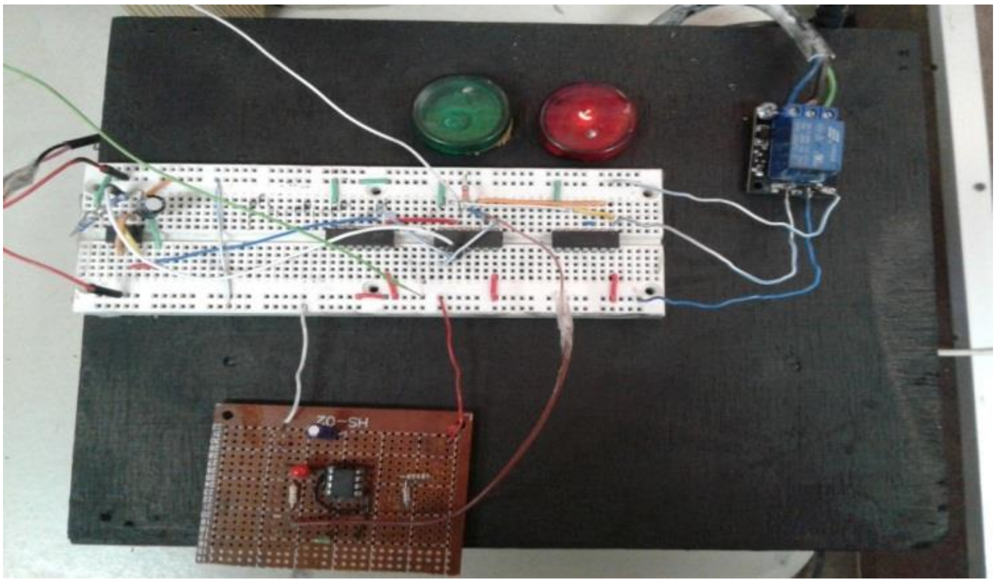

Figure 11: the overall circuit in real board

Finally, the operation of the designed electronic pressure switch can be summarized be using the following flow chart as shown in Figure **12**.

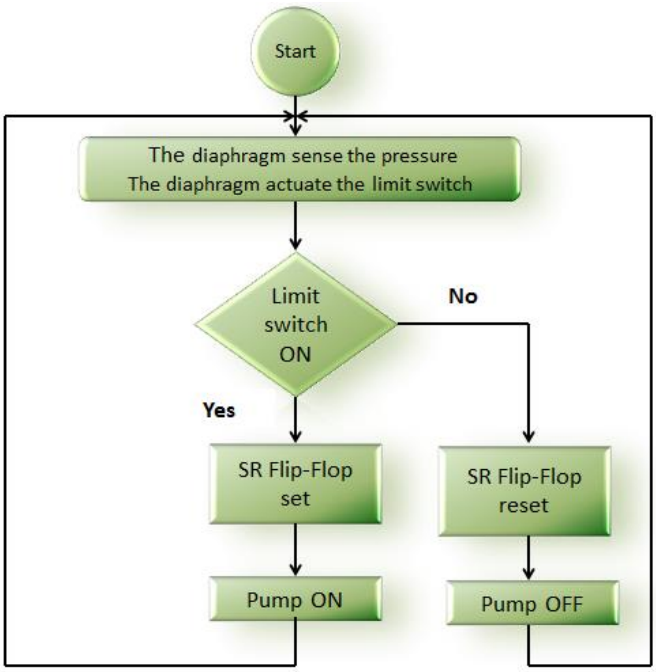

Figure 12 Flow chart.

To operate the designed electronic pressure switch; the pump, non-return valve, and tank process should be added as shown in schematic diagram in Figure **13**and in the real system in Figure **14**.

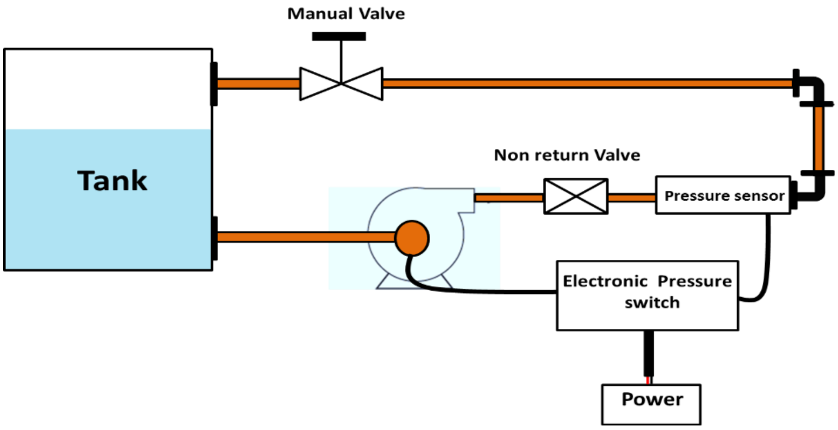

Figure 13: The schematic diagram of overall system.

Figure 14*:* the overall system in real board.

Conclusion

The Electronic pressure switch has been designed and implemented successfully. The main goal for this project has been achieved to Get rid of the chatter phenomenon problems that has bad effect on the electrical devices and instrumentation and make insure that there a perfect pressure in the pipes , Our project has been achieved by using simple logic circuit and electronic combined comparing with the commercially electronic pressure switch that sold in the market , Our electronic pressure switch has been a very good in the industrial work or in the delay work operation.

References

[1] E. Gassmann, *Introduction to Pressure Measurement*. New York, NY, USA: American Institute of Chemical Engineers (AIChE), 2014.

[2] Kilian, *Control Technology-Components and Systems*. [Online]. Available: https://example.com/kilian-control-technology.pdf

[3] D. Lowe and D. Ross, *Electronics All-in-One for Dummies*. 2nd ed. Chichester, UK: John Wiley & Sons, 2014.

[4] C. Platt, *Make Electronics: Learning Through Discovery*. 1st ed. Sebastopol, CA, USA: Maker Media, 2009.

[5] R. E. Bicking, *Pressure Sensors*. [Online]. Available: https://example.com/pressure-sensors.pdf

[6] W. Y. Mousa, *Clock Generator Circuits and Counters*. [Online]. Available: https://example.com/clock-generator-circuits.pdf

[7] "IC 555 Multivibrator Circuits," [Online]. Available: https://example.com/ic-555-multivibrator-circuits.pdf

[8] Electronics Hub, "SR Flip-Flop Design with NOR and NAND Logic Gates," *Electronics Hub*, Apr. 2, 2024. [Online]. Available: https://www.electronicshub.org/sr-flip-flop-design-with-nor-and-nand-logic-gates/

[9] Instrumentation Toolbox, "Mechanical Pressure Sensors," *Learning Instrumentation and Control Engineering*, Feb. 2011. [Online]. Available: https://www.instrumentationtoolbox.com/2011/02/

[10] Circuit Basics, "Setting Up a 5V Relay on the Arduino," *Circuit Basics*. [Online]. Available: https://www.circuitbasics.com/setting-up-a-5v-relay-on