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PLC BASED PNEUMATIC STAMPING AND ITEM COUNTING SYSTEM

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Abstract

This system is done to simulate and demonstrate the process sequence of pneumatic stamping and item counting system. The system is controlled and signaled by Kinco K2 series PLC. The programming software of Kinco PLC is KincoBuilder software. Kinco K2 series PLC is been selected because it has its own capabilities and designated symbols. There are five types of PLC programming languages but ladder diagram program is used to control the system. And, a control panel is also set up in hardware setting to be systematic system. Programmable Logic Controller (PLC), 24V DC power supply, eight pin relays and connectors are placed in the control panel and push buttons and pilot lamps are placed at the front cover of panel. This machine can be used in post office, school, and colleges for stamping. It is also use in many industries.

Keyword: PLC, Photoelectric sensor, 12V DC Gear motor Solenoid valve, Double acting pneumatic cylinder, Compressor.

1.INTRODUCTION

Pneumatic stamping and item counting system is one in which the stamp is applied to each item by pneumatic cylinder and stamped items are counted by counter. This system consists of two conveyor belts by two DC gear motors. This process will be driven by pneumatic cylinder. The pneumatic cylinder is incorporated by solenoid valve. Sensors are used in order to provide position feedback and status information. In this system, pneumatic stamping system and item counting system will be controlled by Kinco K2 series PLC, ladder diagram program on KincoBuilder software.

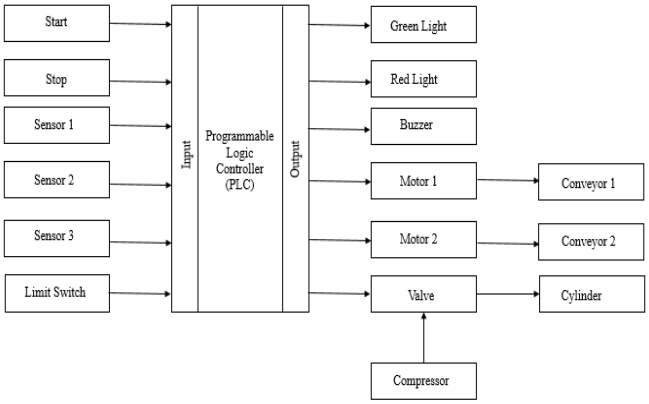

Figure 1. Block diagram of the system

The block diagram of the proposed system is shown in Fig. 1 which consists of five inputs (push buttons, two photoelectric sensors and limit switch) to provide the control by the system state. Also the system consists of four outputs (12V DC gear motor, indicators and buzzer).

2.POWER SUPPLY OF SYSTEM DESIGN

In this pneumatic stamping system, the main AC power supply, 220V is fed to Kinco power supply and three pilot lights. Then, Kinco power supply is step down type of transformer, so that converts 220V AC to 24 V DC for PLC, solenoid valve, limit switch and three photoelectric sensors. Moreover, the gear motor, buzzer and air compressor are driven by 12V DC battery. So, the voltage values of 220V AC, 24V DC and 12V DC are required for this system. The following block diagram Fig. 2 is the power supply system of this pneumatic stamping system.

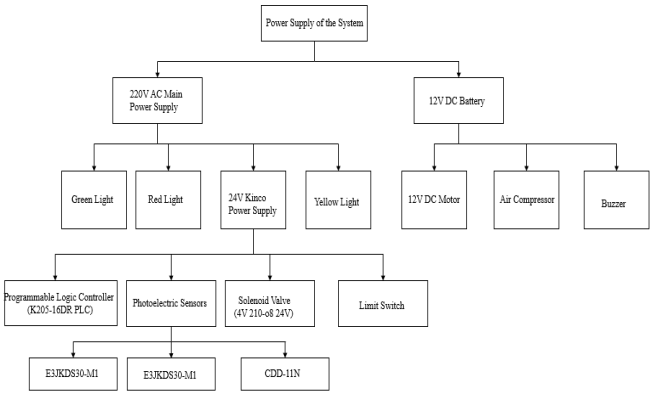

Figure 2. Block Diagram of Power Supply System

3.DESIGN CONSIDERATION OF THE HARDWARE COMPONENTS

Before the system is setting up, it is prepare to consider what components are suitable for the system and how they should be arrange in hardware setting.
There are two kinds of cylinder, single acting and double acting types. Double-acting cylinders use compressed air for movement in both directions. In Fig. 3 shows the double-acting cylinder, use more air (both for extend and retract) for loads that require both pushing and pulling.

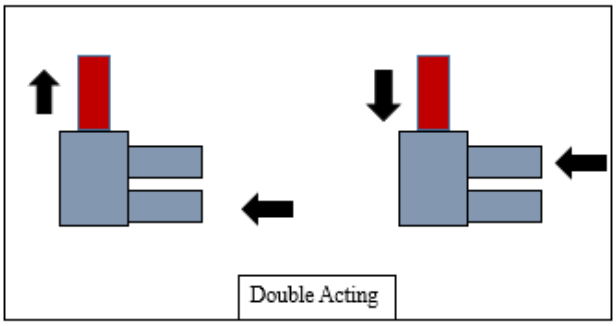

Figure 3. Double Acting System

The cylinder does not need much force for stamping on an item which is not metal and the cylinder piston also does not need to move fast. So, low-pressure air compressor without tank is suitable for this pneumatic stamping machine and an external air tank and non-return valve are added to it to get steady pressure. It is more cost effective than compressor with tank. Air tank, sometimes referred to as receiver, is an integrals part of any compressed air system. The main purpose of this is to act as temporary storage to accommodate the peaks of demand from the system. So, the air tank is used to store compressed air before it enters into the piping system and cylinder.

Figure 4. Design of Air Tank and Compressor

A solenoid valve is electromechanical device in which the solenoid uses an electric current to generate a magnetic field and there by operate a mechanism which regulates the opening of fluid or air in a valve. For cylinder control, the simplest method is to use a 3-way valve for a single-acting cylinder and a 4-way or 5 way valve for a double-acting cylinder. Fig. 5 shows the design of bi-stable 5/2 way solenoid valve

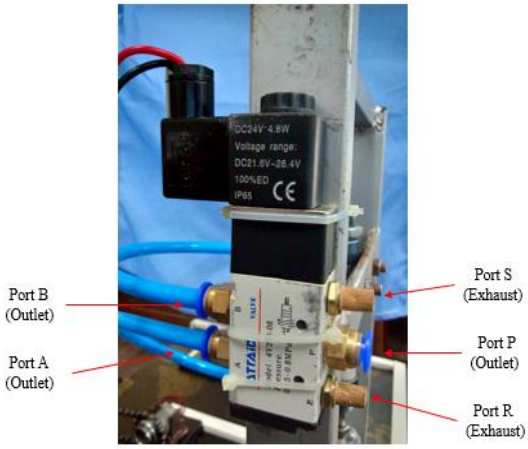

Figure5. Design of bi-stable 5/2 way Solenoid Valve

The conveyor in this pneumatic stamping system is driven by 12V gear motor. This conveyor is built with mounted ball bearings, chain, chain guard and steel rods (shaft).The length is 88 cm and the width is 1.5. And, this conveyor has four revolution per minute. Fig.6 shows the design of conveyor motor drive.

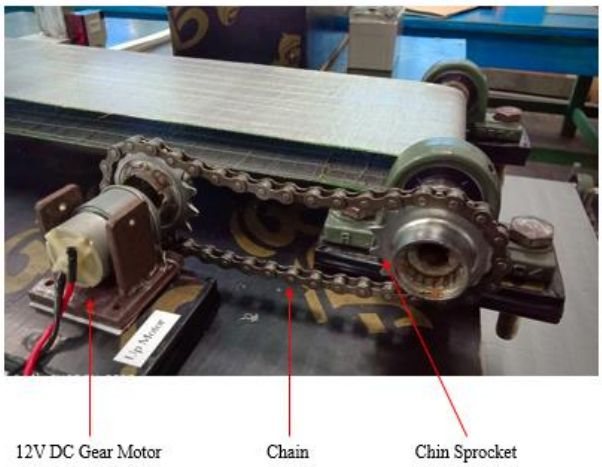

Figure 6. Setting of Conveyor and Motor

Then, second photoelectric sensor is used for counting the items. After the stamping process, the stamped box is comming from the upper conveyor belt and drop to the empty box which is on the sencond coveyor. The second photoelectric sensor is placed under the upper conveyor belt. The sensing distacen is 11 cm and placed near the sencond counveyor belt. Fig.7 shows the design of second photoelectric sensor.

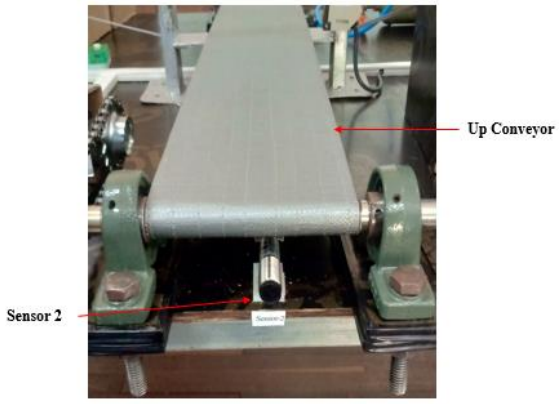

Figure 7. Second Photoelectric Sensor

And then, the third photoelectric sensor is placed beside the second conveyor belt. This sensor is used to sense the presence or absence the item. The empty box is coming when the down conveyor is start to in fironf of the third photoelectric sensor. The box is reached to the photoelectric sensor, the down conveyor is stop and wait until the falling of threee stamped box. After working, move to the distination and touch the limit switch. Then, buzzer is alram to reach the box is reached. Fig.8 shows the place of third photoelectric sensor.

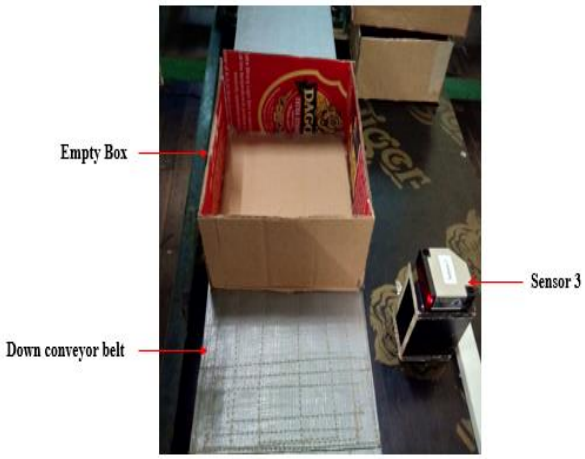

Figure 8. Third Photoelectric Sensor

After the empty box is full with the stamped boxes, is coming to the distination. Limit switch is placed at near the end of down conveyor.When the box is touch the limit switch, the buzzeer will alarm.Fig.9 shows the limit shitch.

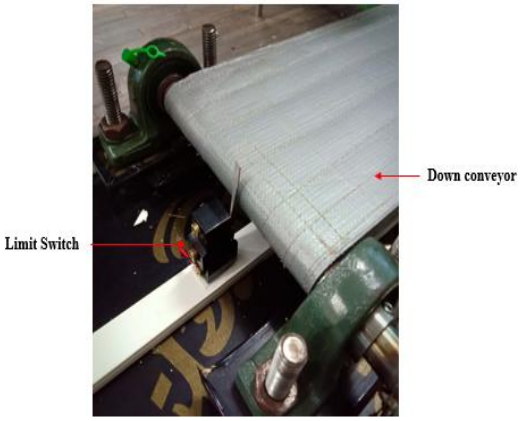

Figure 9. Limit Switch

4.OPERATION OF THE SYSTEM

When the start button is pressed, conveyor motor B is operated. This motor drives the down conveyor and then the empty box is put on that conveyor. When the empty box reaches in front of third photoelectric sensor (Sensor 3), the conveyor motor B has stopped to wait three counted items. A delay time is set after the three items are counted by second photoelectric sensor (Sensor 2). The down conveyor will return operate at this time. It stops operating when stamped items carrying box is touch to limit switch.

As soon as third photoelectric sensor (sensor 3) senses the empty box, conveyor motor A drives the up conveyor. Then, items are put on the up conveyor. Once an item reaches in front of first photoelectric sensor (sensor 1), the sensor senses the presence of item and informs to the PLC. At this time, the up conveyor stops activating for making stamping action. A delay time is set before stamping action. There are three steps in stamping action. The first is the forward motion of the cylinder piston. The second step is stamping on the item. The last one is the reverse motion of the piston. The former two steps happen when 24V DC power to solenoid valve is on. After stamped, conveyor motor A runs again and a stamped item reaches in front of second photoelectric sensor (sensor 2). Second photoelectric sensor (sensor 2) counts the stamped item and counted item is fall into empty box. After second photoelectric sensor (sensor 2) has counted three stamped items, the conveyor motor A stops operating. It runs again when third photoelectric sensor (sensor 3) is sensed. Then, the stamped items filling box on the down conveyor move toward the end of conveyor and touches to limit switch. It informs to the PLC and stops the conveyor. And then, the buzzer rings simultaneously. At that time, the box is needed to remove it. The design of pneumatic stamping and item counting system is shown in Fig. 10.

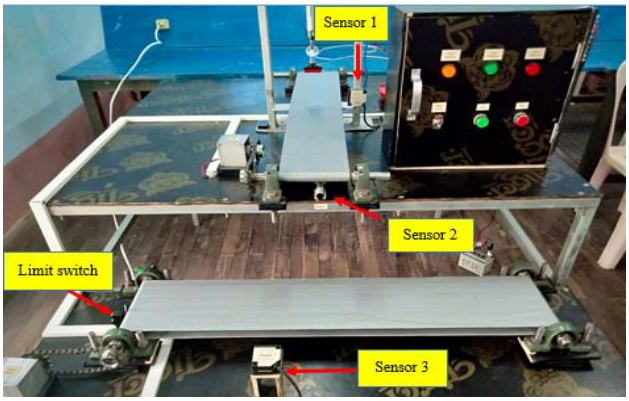

Figure 10. Design of Pneumatic Stamping and Item Counting System

5.HOW TO CONNECT THE COMPUTER WITH THE KINCO-K2

The CPU module provides an integrated RS232 or RS485 serial communication port to communicate with other equipment. The initial screen when starting up KincoBuilder is displayed. Click the button [File>>New] in KincoBuilder. Fig. 11 shows KincoBuilder screen.

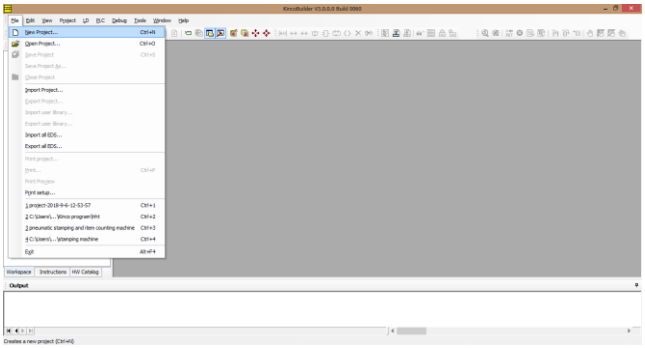

Figure 11. KincoBuilder Screen

6.LADDER DIAGRAM FOR PNEUMATIC STAMPING AND ITEM COUNTING SYSTEM

The following are ladder diagram program of pneumatic stamping and item counting system.

6.1. Starting Condition

When start button is pressed, the system gets the power and green pilot lamp is lightened. The power contact is

latching because the power is required until a stop button is pressed.

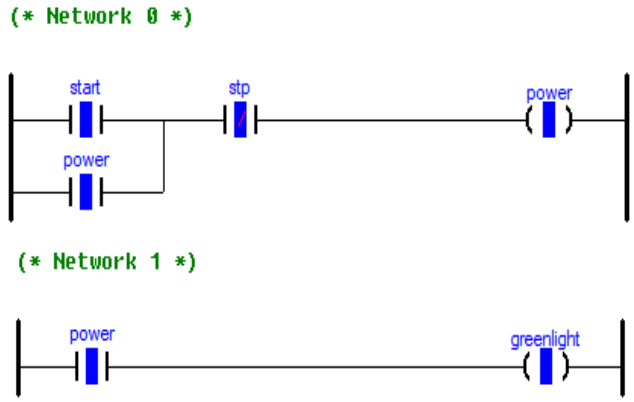

Figure 12. Simulation Result for Starting Condition

6.2. Stopping Condition

When stop button is pressed, red pilot lamp is lightened and the power is cut off.

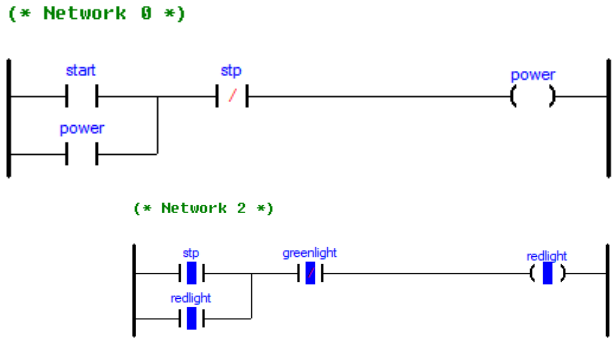

Figure 13. Simulation Result for Stopping Condition

6.3. Down Conveyor Operating Condition

When the system gets the power, down conveyor operate to carry empty box. It is operating at sensor three and limit switch not sensing state. When stamped item carrying box is touch to limit switch, the buzzer rings and the down conveyor stops operating.

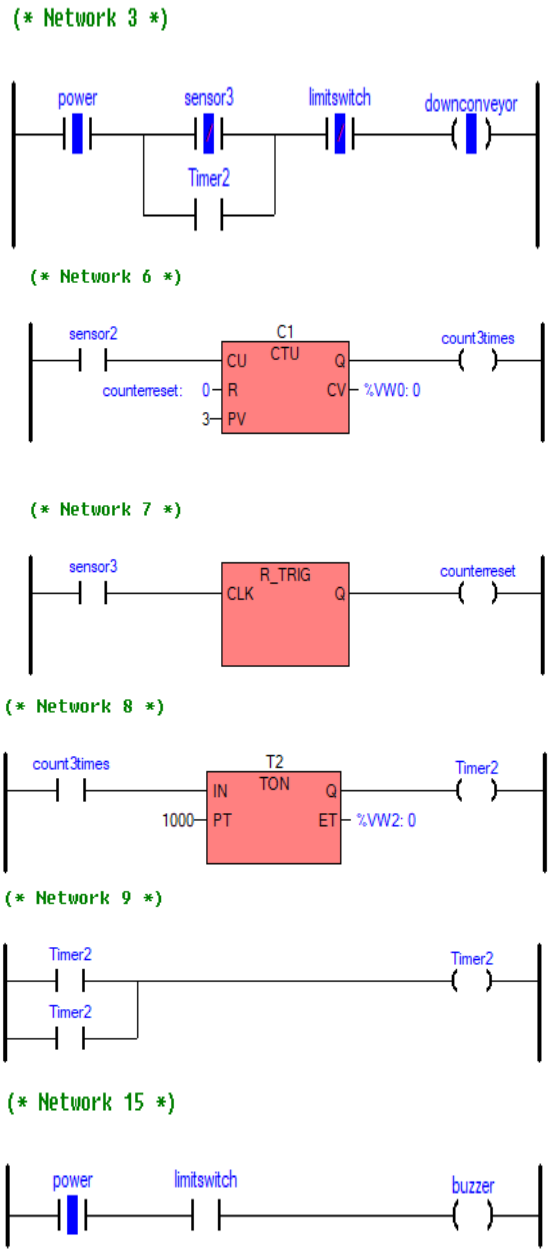

Figure 14. SimulationResult for Down Conveyor Operating

6.4. Up Conveyor Operating Condition

Up conveyor operates at sensor one is in not sensing state and sensor three is in sensing state. It operates at sensor two is not counting state and after stamping state. Rising edge detector instruction is used to reset the counter when another empty box is reached in front of sensor three.

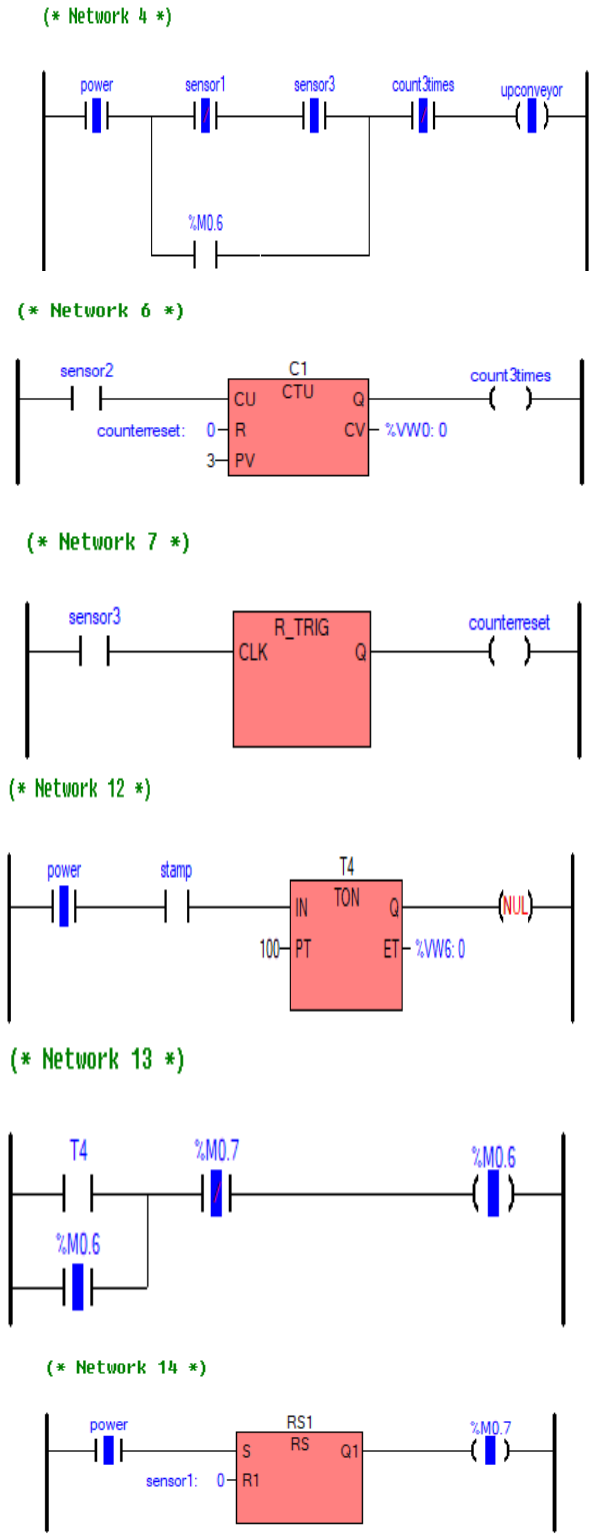

Figure 15. Simulation Result for Up Conveyor Operating

6.5. Stamping Condition

Stamp action operates after timer (T3) activates. After stamping, timer (T4) is activating for the reverse motion of the piston. Sensor one has to reset because the power supply to the valve needs to switch off.

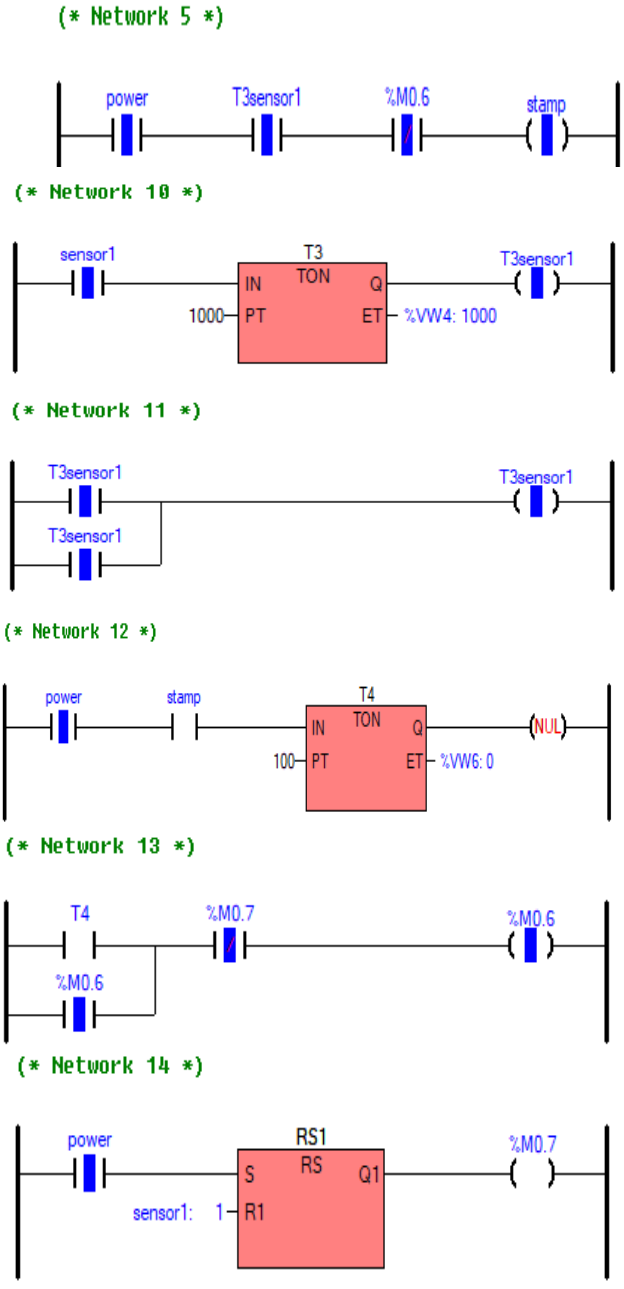

Figure 16. Simulatoion results for stamping condition

7.TEST AND RESULT OF THE SYSTEM

Results are the ultimate objective of a research. And, results are presented in the form of both the software simulation and hardware operation. Simulation results are got by running continuously the program by using the KincoBuilder software and actual hardware operation results is shown below.

7.1. Test and Result for Sensor Three

This motor drives the down conveyor and then the empty box is put on that conveyor. When the empty box reaches in front of third photoelectric sensor (Sensor 3) is shown in Fig 17.

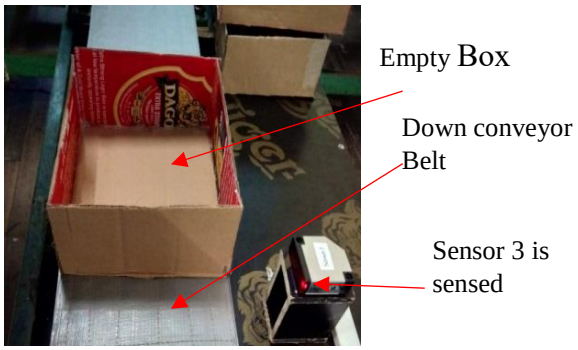

Figure 17. Sensor Three Sense Condition

7.2. Test and Result for Sensor One

After the down conveyor has stopped, the up conveyor motor start running. The items are put on the one side of conveyor. Once the item is in front the sensor one, the sensor one senses inform to the PLC. Then the up conveyor is stopped and stamping action starts.

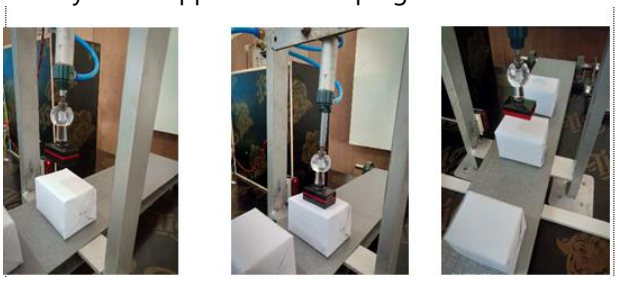

Figure 18. Stamping Condition

There are three steps in stamping action. The first is that the solenoid valve gets power in the cylinder piston moves in forward direction. The next is the stamp which is joined with the piston of cylinder touches with the item. The last is the power which is applied to the solenoid valve is cut off and then the stamping complete.

7.3. Test and Result for Sensor Two

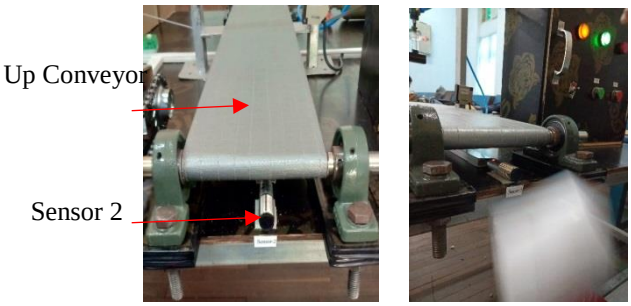

Figure 19. Sensor Two and Item Counting

The stamped items move to the other side of up conveyor and these are ready for counting. The stamped items drop to the down conveyor passing through the sensor two. The sensor two senses the passing items for counting.

7.4. Test and result for Limit Switch

When limit switch is detected moving box, the buzzer will cause the alarm to sound.

Figure 20. Limit Switch

8.CONCULSION

The pneumatic stamping and item counting system was accomplished with successful demonstration and testing. This machine can be used in post office, school and colleges for stamping on post cards, items and identity cards etc. By changing the rubber stamp this machine can be used for giving any shape and size of mark on the card like logo, signature etc. The design provides comfort for operator and the operation is

efficient and satisfactory. As the stamping and item counting system is controlled by Programmable Logic Controller, so, time and human energy can be saved and human energy can be reduced because of automation. And, this system has high effectiveness and accuracy.

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