RESEARCH ARTICLE

DOI: 10.34256/bsr1923

BULLETIN OF SCIENTIFIC RESEARCH

Design and Fabrication of Automatic Fuse Insertion Machine

M. Raghunath [a], K. Nijandhan [a], S. Vijay Dharan [a,*], T. Saran [a], V. Shri Sakthi [a]

[a] Department of Mechatronics, Bannari Amman Institute of Technology, Tamil Nadu, India.

*Corresponding Author:vijaydharan.mc18@bitsathy.ac.in DOI: https://doi.org/10.34256/bsr1923

Received: 03-08-2019
Accepted: 29-10-2019

Abstract: Fireworks are a class of low explosive pyrotechnic devices used for aesthetic and entertainment purposes. In our project, we automate the fuse insertion process of the Chinese cracker (Bhijili). In India, the fuse insertion is done by handmade process. Due to handmade process, it creates serious health problems to the labours and it requires more labour, consumes more time. So, we planned to implement this process in a "PLC based automatic machine". In which we combined Piercing, Dipping and Fuse Insertion. In reference of cracker manufacturing in China, they already had automatic fuse insertion, but they have a different procedure (chemical filling is done after the fuse insertion) compared to our country's procedure, fuse is inserted after chemical filling. In our automation, we sequence the process of piercing and fuse insertion in an automatic manner. Advantage of our project are, increases productivity, reduced lead time, elimination of setup time, reduce the cost, fewer accident. For an emergency safety to the human and the surroundings, we use the fireball (mono ammonium phosphate) for the occasional fire accident which reduces the concentration of the blast in a few seconds.

Keywords: Pyrotechnics, Fireworks, Crackers, Fuse, Arduino uno, Stepper motor, Roller and cutter.

1. Introduction

1.1 Pyrotechnics

Pyrotechnics is the science of using materials capable of undergoing self - contained and self-sustained exothermic chemical reactions for the production of heat, light, gas, smoke and/or sound. Its etymology stems from the Greek word's pyro ("fire") and tekhnikos ("made by art") [1]. Pyrotechnics include not only the manufacture of fireworks but items such as safety matches, oxygen candles, explosive bolts and fasteners, components of the automotive airbag and gas pressure blasting in mining, quarrying and demolition. Individuals responsible for the safe storage, handling, and functioning of pyrotechnic devices are referred to as pyrotechnicians.

1.2 Fireworks

Fireworks are a class of low explosive pyrotechnic devices used for aesthetic and entertainment purposes. The most

Common use of a firework is as part of a fireworks display (also called a fireworks show or pyrotechnics), a display of the effects produced by firework devices. Fireworks competitions are also regularly held at a number of places. Fireworks take many forms to produce the four primary effects: noise,

light, smoke, and floating materials (confetti for example). They may be designed to burn with colored flames and sparks including red, orange, yellow, green, blue, purple, and silver. Displays are common throughout the world and are the focal point of many cultural and religious celebrations.

1.3 Basics of fireworks

The most common feature of fireworks is a paper or pasteboard tube or casing filled with the combustible material, often stars. A number of these tubes or cases are often combined so as to make, when kindled, a great variety of sparkling shapes, often variously colored. The skyrocket is a common form of firework, although the first skyrockets were used in war. The aerial shell, however, is the backbone of today's commercial aerial display, and a smaller version for consumer use is known as the festival ballin the United States. Such rocket technology has also been used for the delivery of mail by rocket and is used as propulsion for most model rockets**.**

1.4 Problem identification

In small scale industries, they are struggling in production rate, safety and maintenance. During these operations impact, friction, spark and heat stimuli may occur and, under certain conditions, one or more stimuli may be enough to cause ignition of the compositions [2]. Accidents can occur if fireworks are handled carelessly during production. They are more harmful to the society as they pollute our environment which affects infants, children, pregnant women, patients and senior citizens. The lifespan of the workers, their families and their surroundings are affected due to the improper handling of fireworks during manufacturing. Due to these reasons, we planned to automate this process. It reduces accidents due to improper handling of the chemicals by the workers. In our automation, the working place of the labour and the machine are in separate places. The labour only handles the control panel of the machine. So, it is very safe for labour than the handmade process.

2.Technical Details

2.1 Physical Measurement

- Overall size not exceeding 75mm in length and 15mm in diameter.
- Inner shell maximum length 57.5mm, diameter maximum 8mm and thickness 0.5mm as shown in figure 1.
- Maximum four numbers of papers wrapping in the form outer shell and fitted with fuse of 6-9 sec delay.

Figure1. Inner and Outer shell

2.2 Chemical Composition

- Aluminum powder (999): 0.138g(23 %)
- Sulphur: 0.120g (20 %)
- KNO_3: 0.342g (57 %)

2.3 Weight

- Weight of Chemical not exceeding 0.6g per cracker.
- Packing Bulk density not exceeding0.6 g/cc per cracker.

2.4 Steps of Process

- Tube rolling
- Arranging of Tube

- Mud coating
- Paper coating & Piercing
- Chemical Filling
- Mud Coating Piercing
- Fuse Dipping & Insertion

2.5 Fuse dipping and insertion

Below Figure 2 shows the fuse dipping and insertion process in Chinese Cracker by handmade.

Figure 2. Fuse insertion

2.6 Xy Table

X-Y tables help provide horizontal motion for the automated machinery such as assembly robots in manufacturing facilities. Robotic arms and other automated machinery have only a limited range of motion while their bases remain stationary; X-Y tables allow this basis to move horizontally along the X and Y axis. Also known as XY stages, XY tables are motorized linear slides with linear motion based in bearings which are driven by a drive mechanism, typically a linear motor. XY tables are built and configured to provide high-performance positioning along multiple axes. XY tables are flat surfaces mounted on ball bearing slides or roller slides with multiple linear bases and are composed of forcers and platens. The force glides over the platen on frictionless air bearings and moves continuously in a linear motion across the platen [3]. To create multiple axis, linear bases are often stacked on top of one another, with the top "Y" axis acting both as a carriage to the bottom base and as the base which holds the table. Adjustable gibs can be attached on both axes. These types of XY tables, used frequently for the movement of robotic, are often called "positioning tables". Materials used to construct XY tables include stainless steel and cast iron as well as bronze for bearings and aluminum for frames.

2.7 Parts of XY table

- Stepper motor
- Lead screw
- Cylindrical rod
- Linear bearing
- Rotary bearing
- Coupling
- Fitting

2.8 Roller Feeding Mechanism

The roller feeder is used to feed the continuous threads. In which 10 thread are arranged horizontally. When the roller is rotated the thread is fed into the dipping container and rotated in reverse direction and then place in the shell.

2.9 Parts of Roller feed mechanism

- Stepper motor
- Roller bearing
- Spur gear
- Support pulleys
- Two wooden rollers
- Fasteners
- Coupling

2.10 Cutting mechanism

Two parallel plates with 10 holes. One is fixed and another plate is moved in

horizontal direction through cam follower mechanism. The cam is coupled with roller stepper motor [4].

2.11 Parts of Cutting mechanism

- Parallel plates with holes
- Cam follower
- Timing belt for coupling
- Timing belt pulleys

2.12 Electrical parts

The electrical parts used in the project are mentioned below.

- MCB
- SMP
- Stepper motor
- Wires
- Control
- panel
- Frame
- Connector
- Cooling fans
- Arduino UNO
- Stepper motor drive

2.13Flow chart

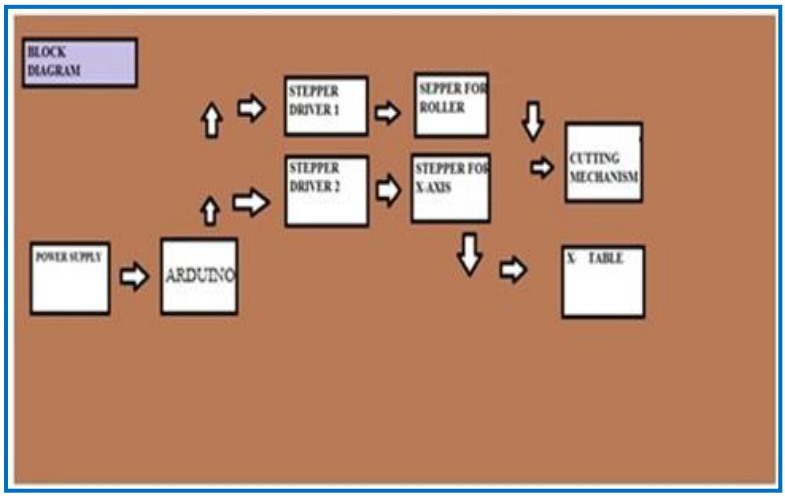

Figure 4. Technical Flow Chart

3. Experimental setup

3.1 Frame

We have to convert circular frame into square frame. Shells are arranged in 2 dimensional arrays in this rectangular frame. This square arrangement is appropriate for machine setup. Square array consist of 10 x10 shells as in figure 3.

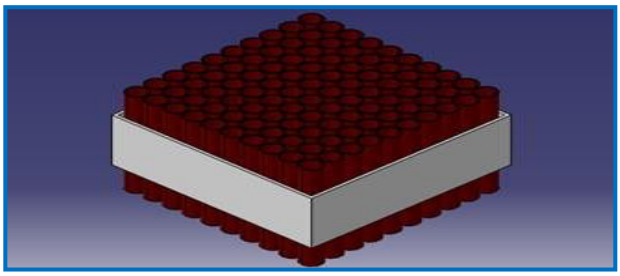

Figure 3. Cad model of square frame

In the above Figure 4 shows the power supply for the system, PLC setup and motor setup for all the mechanisms used in the machine

In the above Figure 5 explain the step by step process of piercing, dipping & fuse insertion process.

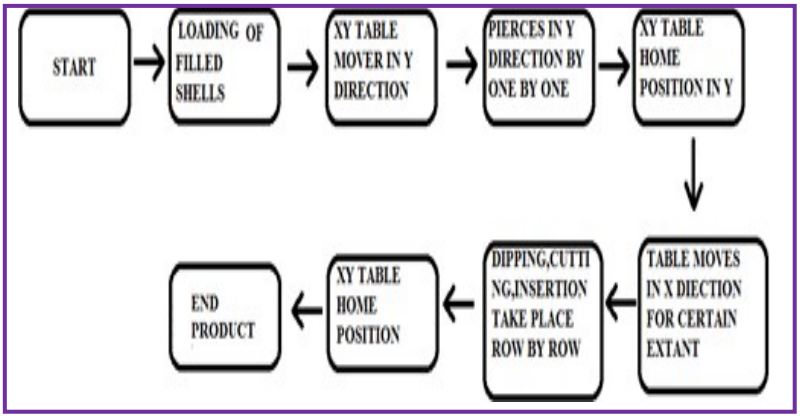

Figure 5. **Sequence Flow Chart**

3.2 Roller feed & cutting mechanism

- This mechanism is used to feed the fuse thread into the holding frame.
- The cutting plate cuts the fuse thread according to the length

3.3 Arranging & holding mechanism

- This mechanism arranges the fuse into 2D array.
- This mechanism uses lead screw used to convert rotary into linear motion

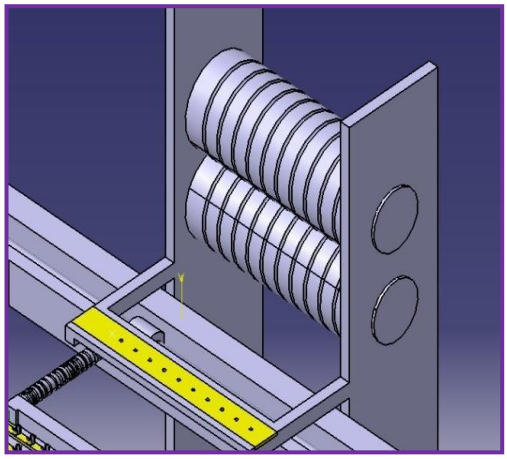

Figure 6. **Cad model of roller**

3.4 Horizontal moving mechanism

This mechanism uses the pneumatic cylinders to move the holding frame to left and right motion in figure 7.

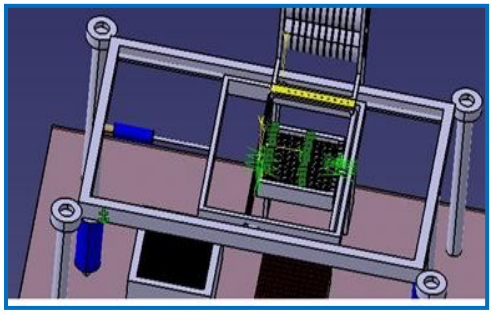

Figure 7. **Design of Horizontal Moving Mechanism**

3.5 Vertical dip & drop mechanism

It moves the holding frame into the chemical and drops the fuses into the shells.

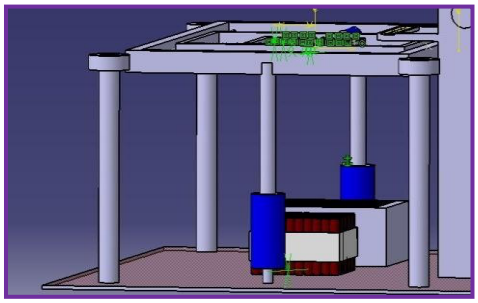

Figure 8. **Vertical dip and drop mechanism**

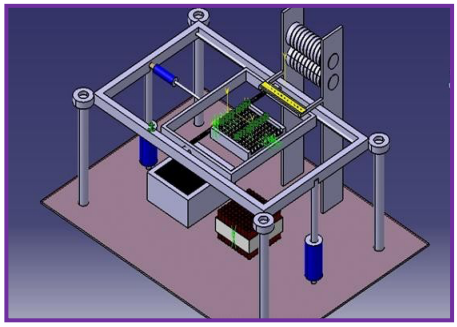

Figure 9. **Final design**

3.6 Design of an interfacing system

The design of an interfacing system is nothing but the interfacing the machine with the Lab VIEW software. The overall electrical system is connected with the arduino board and then the arduino board is connected to the Lab VIEW software shown in figure 10.

- The design of the fuse insertion machine is completed. The further process is the design is interface with the LAB VIEW to simulate the fuse insertion machine [5].
- The purpose of interfacing with the LAB VIEW is to get the control panel to operate the fuse insertion machine.

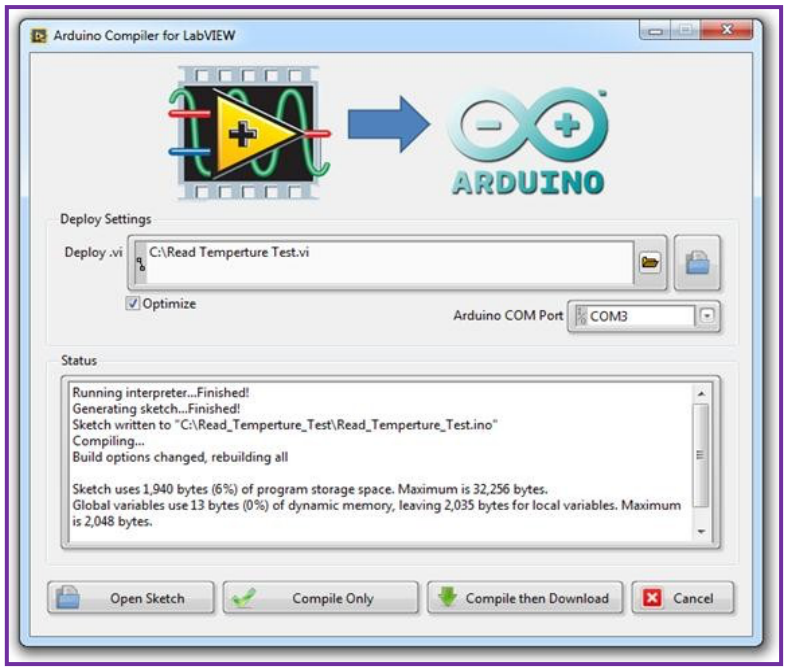

Figure 10. lap view software

3.7 Prototype

Figure 11. Prototype

4. Conclusions

The Automatic fuse insertion machine for Chinese crackers reduces the harness to the labour. It produces more crackers compared to the manmade work. It needs a small number of workers to complete the whole process. In fireworks, the harmfulness to the labour is very high and it cannot be controlled in all time. The continuous work in the industry make a labour illness by slowly inhaling the chemical dusts like sculpture, which may cause death. So, this machine will done the fuse insertion process in an easy way. At present, all the manmade processes are made into the automatic machine. Due to the improper maintenance in the fireworks industry (not follow the guidelines given by Government) make the accident and explosives around the industry. Due to riskiness, the automatic machine must be introduced to produce all crackers in future. Based upon that, this project has a good scope in future and makes the production of crackers in a safe way. This project will surely protect many people's life in and around the fireworks industry.

References

[1] A. Azhagurajan, N. Selvakumar, T.L. Thanulingam, Thermal and sensitivity analysis of nano aluminium powder for firework application, *Journal of Thermal Analysis and Calorimetry*, 105 (2011) 259-267.

[2] Government of India, (2008) Circular to All Fireworks Manufacturers in India, Petroleum and Explosives Safety Organization.

[3] K.N. Ghosh, (1981) The Principles of Firecrackers, (2nd Ed) *Economic Enterprises*, 78-87.

[4] R. Sarathi, T.K. Sindhu, S.R. Chakravarthy, Generation of nano aluminium powder through wire explosion process and its characterization, *Materials Characterization*, 58(2007) 148-155.

[5] J.A. Conkling, (1985) Chemistry of pyrotechnics: basic principles and theory, *CRC Press*, USA

About the License

Copyright © The Authors 2019. This work is licensed under a Creative Commons Attribution 4.0 International License