Design and Fabrication of Automatic Matchstick Counting and Packing Machine

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Abstract—Matchsticks are known internationally as a ritual product in the production industries. The matchstick workers in India lack efficient tools and education to develop better means of processing techniques. The current manual processes are physically exhausting and time consuming to complete the whole process. In order to help matchstick producers, this project focuses on providing a product which automatically counts and packs the matchsticks as per the required quantities. To the best of our knowledge, currently there are only two methods to count match sticks i.e. manual method and weighing method. In manual method the match stick are counted manually before packing which is a time consuming process and also relies on human labour. This also increases the cost of production and lowers the productivity. Many large scale match stick manufacturers used the weighing method to count the match stick, but this method is also not so accurate since the match stick does not have uniform weight. To overcome the drawbacks, we have designed and fabricated a machine which would take care of separating, counting and packing the matchsticks without manual intervention. In our project we use hopper, conveyor and other mechanisms to separate the sticks and to pack the sticks automatically after required number of sticks is counted. The signal from counter helps to actuate the packing mechanism. PIC Microcontroller is used for this purpose. By implementing this machine the counting error may be completely eliminated and the packing time/matchbox will reduce by 75%.

1. INTRODUCTION

Counting and Packing is the major process in a match sticks industries which is an important process which determines the production rate of a manufacturing sector in an industry. The counting and packing of match sticks in the industries are done manually. Hence the production rate in a company is decreased and also has some limitations like shortage of labour, increased wages; handling of sticks directly in bare hand may cause some health hazards to the labour. As the process is continuously done, there are some possibilities of mental stress. To eliminate these problems, we have designed an automatic match box filling machine which counts and packs the sticks automatically. The economic development of a country is measured on the basis of its industries. Small scale industries in the village functions as a powerful instrument for rapid development of a country like India. Matchstick industries are necessary in the everyday life of human beings. Match industry has mass production and increases employment opportunities in the country. It plays a huge role in building up the economic structure of the country. Safety matches are very old in India. It was in 1894, Amrit Match factory at Bilapur and Gujarat match factory at Ahmedabad were made with the technical assistance from Sweden. A family venture has been lagging in the growth of the match industries in Kovilpatti town in Tutucorin district. For the effective regulations in the match industries in India and for the levy of excise duty, the Indian Government has classified the various Match units under the classes, naming, A, B, C and D. This classification was made on the production methods. Match industries are flourishing, established and secured industry. The market for an industry is commendable for the prosperous growth. Sale on credit has become an established mode of business trend. Sweden is one of the oldest manufacturers of match industry. The major markets in India are Delhi, Gujarat and Rajasthan.

2. LITERATURE SURVEY

The literature reveals the match stick has a huge demand and a sizeable market both in India and abroad, very little development has taken place in this field. The people involved in this trade are mostly below the poverty line and still use primitive ways of manufacturing match sticks [1]. It was concluded from the existing literature that there is no proper safety measures during matchstick manufacturing to

the workers. The literature review concludes there is a need for improved ergonomic machines and safety design to be introduced there is low or almost no awareness of the new designs and techniques that have been developed in our country [1]. Emerging of new technology in matchstick manufacturing will make India leading producer of matchsticks throughout the world [1] [7].

2.1 OBJECTIVE

To design and fabricate the model for Matchstick counting and packing and the model should be capable of automatically count the number of sticks and the box should insert with the cover automatically and to test the performance and verify the result of the model.

2.2 MATCH INDUSTRIES – AN OVERVIEW

The origin of safety match industries in our country goes back to the beginning of this century. Since 1910 an immigrant Japanese family who settled in Kolkata began making matches with simple and power-operated matches. The localities over there soon learned the required skills and a number of small match factories began in and around Kolkata. These small factories could not meet the whole requirements of the country however, India began to import matches from the countries Sweden and Japan. During World War I, when Swedish could not import matchsticks to India, as Indian market was mainly by importing matches from Japan and by the locals made ones who followed the Japanese pattern introduced in Kolkata. After world war I, factories in Kolkata were could not compete with imports, and handmade match productions shifted to south India, especially in Ramanathapuram and Tirunelveli districts in Tamil Nadu. This shift was because of to the pioneering efforts of P. Iya Nadar and A. Shanmukha Nadar who learnt in Kolkata from Purna Chandra Ray, a local businessman learned the trade in Germany. The Nadars set up a number of manual match industry units in the drought and poor regions in Tamil Nadu, where a combination with the sunny climate, cheap workers and raw materials where available from Kerala it created ideal conditions for match production. The first sulphur match that would burn when brought in contact with the rough surface which was produced in South India in 1923. Mechanization came to the Indian industries in 1924 when M/s.Wimco Ltd (Wimco), started business in 1924 as a unit of the international Swedish Match Company, During the last three decades, the Indian match industry grew quickly. Government policies protected Indian market by placing tariffs based on imported products and favored the expansion of the handmade and small-scale industries through the use of differential taxes.

2.3 METHODOLOGY

The project started with taking survey about the problems in counting and packing of the matchsticks from several districts in TN. Then we came to know about the existing methods and we decided to make some changes in this method. We made a pencil sketch to know about our plan about our project in the form of conceptual sketch after that we made an idea to buy materials for developing our project. Then after the purchase of the required materials we decided to fabricate our machine. Fabrication of our machine comprises of mechanical and electrical components. The mechanical setup was made after that we started to make programs in the electrical board. Our electrical board which is made by the programming embedded C. After that the required connection was given to the motors and sensors in and we made the interface between the mechanical components and the electrical components. After fabrication of our project we made several tests on motors and the sensors which had done in our project. The project was fine tuned and the report was generated.

3   COMPONENTS AND DESCRIPTION

There are different types of components have been used in our project for different operations. The following are the respective components with their specifications and their need in our project

3.1. Pneumatic Cylinder

Pneumatic cylinders are also known as air cylinders that use the compressed gas to produce a force which is used to move in linear directions. Hydraulic cylinders are sometimes called to move in desired directions. The piston is similarly a disc or a cylinder which transfers the force to move a certain object from one place to another. Pneumatics are more preferred because they does not require large amount of space for fluid storage and they are clean and quieter. Pneumatics similarly uses the operating fluid as a gas, such that drip out problem in pneumatic cylinder will not occur and the surrounding environment does not get contaminated where cleanliness is a main requirement.

Fig 3.1 Pneumatic cylinder

3.2. Solenoid Valve

A solenoid valve is normally called as an electromechanical controlled valve. The main features of a solenoid consist of an electric coil which consists of a ferromagnetic core in centre and it is called as a plunger. When the plunger is in normal or off position it closes off a small orifice. Magnetic field is produced in the coil through by the electric current. Force was exerted by the magnetic field in the plunger. Due to this the plunger is moved towards the centre of the coil and the orifice opens. The above details are the basic principle of the solenoid valve.

Fig 3.2 Solenoid valve

3.3. Conveyer belt

A conveyor system is a one which is mechanical handling equipment that is used to move a part of materials from one place to another. Conveyer systems are normally incorporated in heavy and bulky industries. In our project the conveyer system is mainly used to transport the matchsticks from one the hopper to the matchbox. This system allows transporting wide number of matchsticks with quick and efficiently which is very important in counting and packing industries. There are many types of conveyer systems are available and they are changed according to their need in industries. Some types of conveyers includes chain, floor, overhead conveyers etc with which in our project we uses the normal belt conveyor for transportation of sticks from hopper to the matchbox.

Fig 3.3 Conveyer belt

3.4. Battery

Batteries are the one which is used for storing the solar energy which is converted into electrical energy. Batteries play the most important role in any circuit devices and for running of the components. In our project the same operation has been done with 12V 7AH Lead Acid Dry Cell Battery. Batteries are the one which is seemed to be the only storage means either technically or economically. Comparing with the cost availability the batteries are high in their initial costs as well in capital costs. Hence these problems can be eliminated by using the available resources of energy in the environment which is a wider one.

Fig 3.4 Battery

3.5. Motor

The normal motor which operates through the interaction of the magnetic field and coil winding to generate force within the motor. In some applications like transportation industries with the, electric motors it be operated by both motoring and generating. The braking modes used to produce electrical energy from mechanical rotation which can be found in applications such as industrial fans, household appliances, power tools pumps and, blowers machine tools and disk drives, electric motors can be operated by direct current (DC) sources like batteries, motor vehicles or rectifiers. It can be also be operated by alternating current (AC) sources, such energy from power grids, inverters or generators.

Fig 3.5 Motor

3.6. Hopper

A hopper is a funnel-shaped device used to move material from one receptacle to another.

Fig 3.6 Hopper Setup

3.7. Control unit

The Control Unit is also known as CU which is central processing unit (CPU) of the computer which directs the operation of the processer. The control unit comprises of different components which is used to perform various operations for the particular process i.e. counting and packing. In our project our control unit comprises of different parts which includes relays, counters, flux etc .They directs the operation by providing the timing and control signals of other units. CU manages most of the computer resources such that flow of data is directed between the CPU and the other devices.
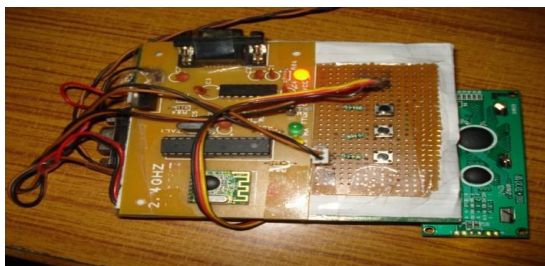

Fig 3.7 Control Unit

4. WORKING PRINCIPLE

Match box packing and counting consists of the above components respectively. The packing section consists of four pneumatic cylinders that will be connected to the solenoid valves. That solenoid valves are connected to the control unit and that is connected to the battery. When the match sticks are flowing through by the hopper the pneumatic cylinder functions are as follows- one pneumatic cylinder is used to move the matchstick middle cover up to bottom of the conveyor. Another cylinder is used to move forward to the match stick box, after the sticks are filled. Another cylinder is used to fix middle cover into the top cover. The top cylinder is used to move the match box at the bottom. Then we will

collect the match box, and then the process will be continuing for repeated interval. Proximity sensors and Infrared sensors are used to count and pack the sticks into the box with the control of control unit.
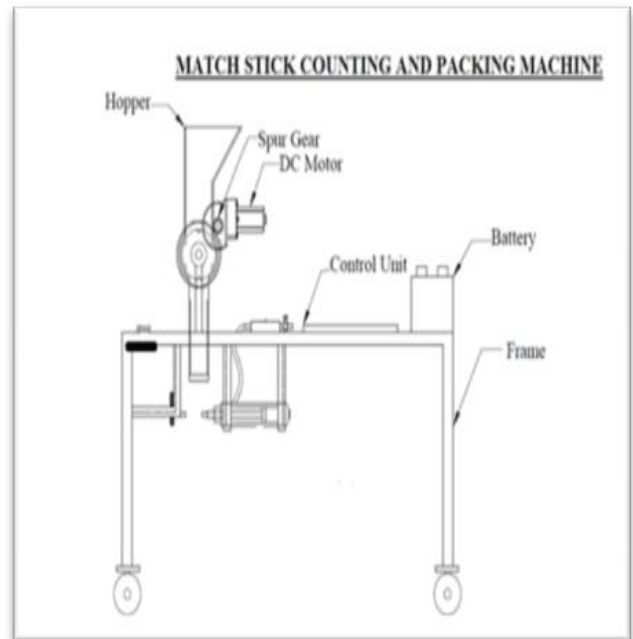
5. SCHEMATIC DIAGRAM

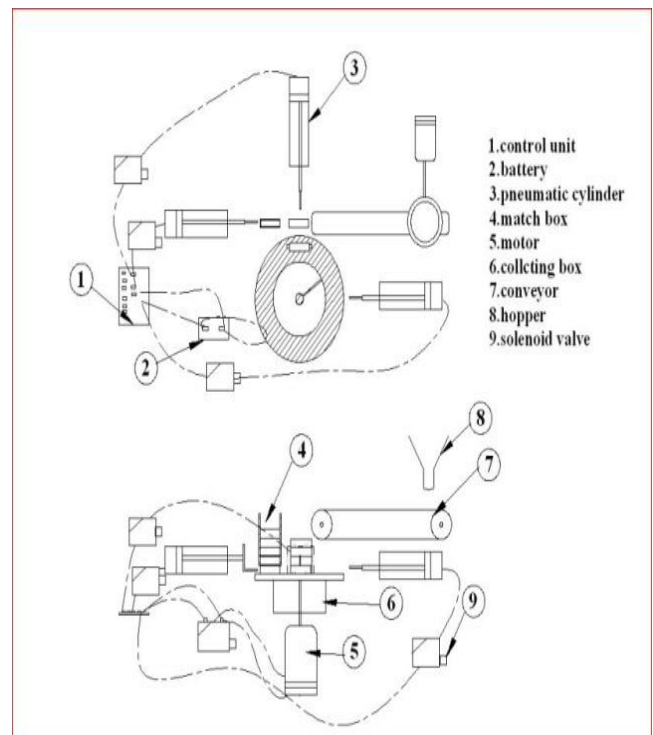**Fig 5.1 Counting Section of the project**

Fig 5.2 Packing Section of the project

Fig 5.3 Completed fabricated model

6. SCOPE OF THE PROJECT

The scope of our project extends with certain applications, advantages and disadvantages which is briefly explained below

6.1 Advantages

i. Match Sticks are efficiently packed with least error.
ii. This method would rule out manual counting and hence being more productive and cost effective.
iii. Even numbers of Match Sticks are counted by using Match Stick packing machine.

6.2 Disadvantages

i. Initial cost is high
ii. High maintenance

6.3 Applications

i. Small and Large scale matchstick industries
ii. Pressing operations

7 CONCLUSION

The main objective of our project is to prepare matchstick counting and packing machine which gives employment to the people in rural area. The fabrication cost of our machine is way cheaper such that normal business sectors can be able to use the machine without any problems. The machine is developed in such a way that it can be easily transported from one place to other. This machine can also be used in small villages of India where women can works from house. The experimental prototype uses different types of electrical, mechanical and electro-mechanical devices. The wiring and installation procedure are also improved because the input and output devices are assigned with specific functions, and thus further simplifies troubleshooting. Cost reduction mainly on the man-power or personnel cost is achieved in this project. Hence, only one or two personnel are needed for the operation and maintenance with the automated system. The machine is fabricated at a cost of Rs.15, 000 with which small scale industries can be capable to buy the product without any difficulties. The machine is capable of replacing 10 labors working at a time and the production rate can be increased at a rate 50% compared to the manual labour. Hence the invested amount can be renewed within a period of 4 months.

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