

Design and Fabrication of Match Splint Packing Machine

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Abstract: In order to reduce child and women labor we had come up with an idea of designing and fabricating the prototype of match splint packing machine. On completion of this project we were able to pack the match splint in the inner box and to cover with the outer box. We have fabricated a packing machine with pair of pulleys, conveyor belt, DC motor, etc... The total estimation is around Rs.7500 /- which is less than the total wages paid in the industries for the workers packing. Comparing the power consumption the apparatus can be operated by 12V DC motor, the battery which is commonly used in the automobiles. The Model can also use to explain how the match splint packing is carried out.

Index Terms - Match splint packing machine, Automation, child labor reduction, safety.

I. INTRODUCTION

A match is a tool for starting a fire under controlled conditions. The match is defined as a narrow piece, usually of wood or cardboard, coated on one end with a compound that ignites when scratched against a rough or chemically treated surface. An easily ignited cord or wick formerly used to detonate powder charges or to fire cannons and muzzle-loading fire arms.

The first known use of matches was in 577 during the siege of a town in northern China. Women in the town used sticks coated with a mixture of chemicals to start fires for cooking and heating, thus allowing them to conserve their limited fuel by putting the fires out between uses.

Match splint is the base of the match sticks. It is the part where the match head is coated. The match splint is made from a wood of a tree such as white pine, basswood, and aspen, pine wood, etc. They are cut into specific dimensions using the cutting machine.

A matchbox is a box made of cardboard or thin wood designed to hold matches. It usually has a coarse striking surface on one edge for lighting the matches contained inside. The chemicals used in striking surface are adhered by means of chemicals and some amount of Gum Arabic.

Mechanization came to the Indian match industry in 1924 when M/s. Wimco Ltd (Wimco), started operations in 1924 as a unit of the multinational Swedish Match Company, Wimco is still the only representative of the large scale sector in wooden match manufacturing and is the only fully mechanized match factory in the country [1]

II. MATCHES MAUFACTURING PROCESS:

Matches are manufactured in several stages. In the case of wooden-stick matches, the matchsticks are first cut, prepared, and moved to a storage area. When the matchsticks are needed, they are inserted into holes in a long perforated belt.

The following are the process involved in the match stick manufacturing.

1. Cutting the matchsticks
2. Treating the matchsticks
3. Forming the match heads

PACKING THE MATCHES:

Now the matchsticks needed to be packed in the inner box and to be covered with outer box. The matchsticks are filled and packed by the following process.

The cardboard inner and outer portions of the match boxes are cut, printed, folded, and glued together in a separate area. If the box is to contain safety matches, the chemicals for the striking strip are mixed with an adhesive and are automatically applied to the outer portion of the box.

When the matches are dry, the belt moves them to the packaging area, where a multi-toothed wheel pushes the finished matches out of the holes in the belt. The outer portions of the match boxes move along another conveyor belt running parallel to the first belt. The filled match boxes are moved by conveyor belt to a machine, which groups them and places them in a corrugated cardboard box for shipping.

Our main objective of our project is to fabricate a machine which reduces the human effort of packing the matchsticks and also to increase the production rate by reducing the time taken during manual packing. By using various mechanisms for filling and packing we thought of fabricating a packing machine.

III. LITERATURE REVIEW

Wooden match production in India is split into three sectoral categories: the mechanized large-scale sector; the handmade small-scale sector; and the cottage sector. 82% of total match production is in the handmade small-scale (67%) and cottage (15%) sectors, where technology has remained relatively simple.

The industry as a whole directly employs an estimated 250,000 people, with only 6,000 of these in the mechanized sector. The cottage sector, which involves totally manual operations and produces less than 75 million match sticks per year and is often household-based, accounts for about 50,000 workers. Thus, small-scale, factory-based match production units employ by far the largest number of people (195,000 workers) involved in the match sector. For every 6 workers employed in the mechanized sector, 22 can be employed in the non-mechanized sector. Men, women, children, the elderly and partially handicapped persons all are employed. The Indian Institute of Foreign Trade attempted a study on the match industry in the year 1979. The study reported on the evolution, the hazards and the employment potential of the match industry [1]. Anantharaman et.al, in his article titled "The Match Makers of Sivakasi IV" has stated that the child in the work place is one of those unfortunate ones tagging along with the mother for want of facilities at home. He has also stated that Sivakasi produces 1.25 laksh gross matches every day and pays excise duty of rupees six lakhs as per day to the government.[2]

Amarjoth explained the human resource management of match industry in Sivakasi. It was found that about 76 per cent girls and 24 per cent of boys were engaged in this match industry. The cause for the employment of more number of female child laborers is the preference shown by employers to female children. In these match industries the contribution of child laborers to their families is sizeable. In total an average of 22 per cent of the total family income is contributed by the children which has substantially increased the income level of the households of the working children. [3]

Ankur Agarwal found that the productivity in manufacturing industry had increased due to technological innovations. There should be organizational reforms and the employees should also be able to keep pace with the technological innovations. A good technology along with due motivation among the employees could make a unit more competitive than others [4]

Shriram et al designed the automatic match box filling machine, through which the production rate can be increased with the decrease in production quantity. His team also concluded, due to automation, health issues can also be resolved [5]

IV. DESIGN OF THE PROPOSED MODEL:

CAD Model:

The proposed CAD model is shown in the Fig.1.

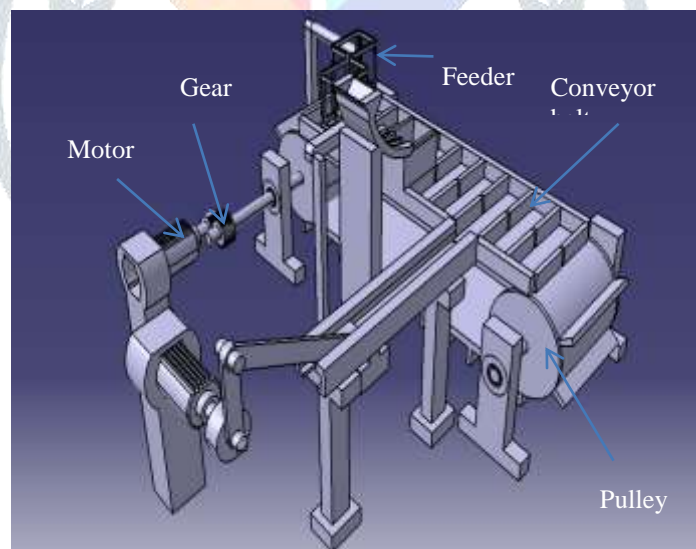


Fig.1. CAD model of the Machine

SPECIFICATION OF THE DESIGN:

In the Table 1 the different components used in the proposed work and their dimensions are listed.

Table 1. Different components and dimensions

COMPONENT	DIMENSION
Casing Frame	Length = 480 mm ; Breadth = 240 mm ; Height = 210 mm.
Gear	Number of teeth = 72 ; Pitch circle diameter = 90 mm ; Module = 1.25 mm.
Pulley	Width = 170 mm. Diameter = 90 mm.
Belt	Length = 1500 mm ; Width = 150 mm ; Thickness = 3mm.
Crank and slider	Crank Length = 90 mm Connecting rod Length = 180mm Ram Dimension L = 36.5 mm ; h = 15mm
Match box	Inner box dimension L = 56mm; B = 35.5mm; T = 15mm Outer box dimension L = 56mm; B = 36.5mm; T = 17mm
Bearing	6202 ball bearing Inner diameter = 17 mm Outer diameter = 35 mm

FABRICATION

The following materials were used in our process of fabrication.

Belt, Bolt, Motor, Bearing, Gear, Battery, Pulley.

Let us discuss the fabrication of certain important parts of our model. The different stages of fabrication is shown in different figures from Fig.2 to Fig.7

PULLEY

Pulley is fabricated at the initial stage. At first PVC pipe is used as pulley which is cut according to the dimensions required. PVC pipe is selected for its low cost, and then it is supported by the Nylon bush which is placed in the pipe.



Fig.2. Reducing nylon diameter and drilling a hole



Fig.3. Fitting of Nylon Bush and Fabrication of Shaft

After fabricating the shaft a ball bearing is added in two sides of the shaft by adding and reducing the metal. Now to avoid the movement of the bearing from the shaft a cover is made over the bearing. Another shaft is covered and extended in order to fit the gear

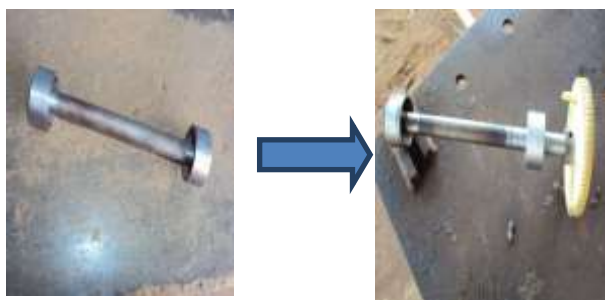


Fig.4. Covering of bearing and fixing of gear in one shaft



Fig.5. Pulley Arrangement

After this the arrangement of the shaft and the bearing is fitted into the nylon bush. Frame is made of mild steel. A rectangular frame is made on the either side and connected by means of the screw which also acts as a path for the belt to avoid the lag on the upper surface while moving over the roller. The frames are connected by the means of the nut and bolt. The frame holds all the components together. The frames are attached together by a long nut and a frame in between them in order to avoid frame to lean on other side.



Fig.6. Frame with fitted parts

GUIDE AND FRAME

A guide is placed in order to separate the inner and outer box from each other. Two edges of the belt are covered by the guide so that when the inner box closes the outer box the box does not fall down. A pathway for the movement of the slider crank is cut in the guide according to the dimensions of the inner box and outer box respectively.



Fig.7. Guide

WORKING MODEL



Fig.8. Working Model (Side View)

Fig.9. Working Model (Isometric View)

The assembled view of the modelled machine in side view and isometric view is shown in the Fig 8 and Fig 9 respectively.

Conclusion:

Thus the match splint packing machine was designed and fabricated as a prototype model to check the working of the proposed model. It was concluded as the cost of the packing machine used in industries is nearly 25, 00,000 rupees/- since it is used in very large production. But in India is concerned most of the matchstick packing is done manually where monthly wages per person is 600 rupees/- per month and nearly 600 to 700 members work in the small sector industries, based on the information collected from the industries. Whereas our project total estimation is around Rs.7500 /- which is less than the total wages paid in the industries for the workers packing. Comparing the power consumption the apparatus can be operated by 12V DC motor, the battery which is commonly used in the automobiles. The Model can also use to explain how the match splint packing is carried out.

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