Design, Fabrication and Testing of a Product Transport Mechanism in an Assembly Line

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***Abstract*—** In an industry, there is a need for transportation of products for performing some operations like labeling, filling, stamping, covering, packing etc. in the assembly line. There has been a need for intermittent movement of products for the above operations. This project work is aimed at designing and fabricating a mechanism using mechanical linkages that delivers this intermittent motion to the products. The mechanism will transfer products from a particular point to another on the assembly line. Here the products are either finished products or in the process of completion. Various processes like stamping, covering, filling etc. can be easily done using this mechanism. The mechanism is designed, fabricated and tested and its function is found to be satisfactory.

Keywords: Fabrication, Product Transport Mechanism, an Assembly Line

I. INTRODUCTION

There has been always a demand for intermittent movement of products, work pieces and packages in the industries for performing various operations on those products. Though the continuous movement is important, in the same field the intermittent motion is also equally essential for many operations. This work aims to produce a mechanism that delivers this stop and move motion using mechanical linkages. The advantage of the system over the conveyor system is that the system has a time delay between moving products and this delay can be used to introduce any alteration in the product or move the product for any other purpose like covering, stamping, filling etc. When in conveyor system such actions cannot be performed unless programmed module is used to produce intermittent stopping of the belt which basically is costly. The prototype design requires electric motor, shafts and the frame of which the frame and platform on which the products are moved is fabricated. Majority of the links are being made of wood which reduces the weight of the whole system including the rail system which has a direct contact with the products being moved. The prototype system is expected to move small size and low weight products.

II. LITERATURE REVIEW

Various researchers have tried to impart intermittent motion for transporting boxes and packages in the industries using different techniques as found from literature.

1) Parveen et al (2017) designed a chain and gear crank mechanism for transportation of boxes of weight approximately 8 to 10 kg. The chain and gear crank mechanism has an electric motor, shafts, and frame where the boxes are placed and moved through direct contact.
2) Kothule et al (2017) designed and fabricated a box moving mechanism where a box blank is folded into a box form and these boxes are transferred by means of a conveyor. The boxes and wrappers are conveyed to a box wrapping machine where the wrapper is folded around and glued to the box. The prototype design requires an electric motor, shafts and the MS frame and platform on which the packages are moved.
3) Krishna and Moulali (2017) designed and fabricated a similar mechanism for box transfer where all the links are being made of Aluminum which reduces the weight of the whole system. The system is capable of moving packages of 2-3 kgs of weight approximately.

III. THEORY

A. Kinematic Link or Element

Each part of the machine, which moves relative to some other part, is known as a kinematic link or element. A link may consist of several parts, which are rigidly fastened together, so that they do not move relative to one another.

A link or element needs not to be a rigid body, but it must be a resistant body. A body is said to be a resistant body if it is capable of transmitting the required forces with negligible deformation.

Thus, a link should have the following two characteristics:

1) It should have relative motion, and
2) It must be a resistant body.

B. Types of Links

In order to transmit motion, the driver and follower may be connected by the following three types of links.

- Rigid link: A rigid link is one which does not undergo any deformation while transmitting motion. Strictly speaking rigid links do not exist. However, as the deformation of a connecting rod, crank etc. of a reciprocating steam engine is not appreciable; they can be considered as rigid links.
- Flexible link: A flexible link is one which is partly deformed in a manner not to effect the transmission of motion. For example, belt, ropes, chains and wires are flexible links and transmit tensile forces only.
- Fluid link: A fluid link is one which is formed by having a fluid in a receptacle and the motion is transmitted through the fluid by pressure or compression only, as in the case of hydraulic presses, jacks and brakes.

C. Properties of Machine

1) The parts of a machine moves relative to one another.
2) A machine transforms the available energy into some useful work.
3) The links of a machine may transmit both power and motion.

D. Kinematic Pair

The two links or elements or machine, when in contact with each other, are said to form a pair, if the relative motion

between then is completely or successfully constrained (i.e. in a definite direction), the pair is known as kinematic pair.

E. Inversion of Mechanism

When one of the links is fixed in a kinematic chain, it is called a mechanism. So we can obtain as many mechanisms as the number of links in a kinematic chain by fixing, in turn, different links in a kinematic chain. This method of obtaining different mechanisms by fixing different links in a kinematic chain is known as inversion of the mechanism.

F. Four-Link Mechanism

One of the simplest examples of a constrained linkage is the four link mechanism. A variety of useful mechanisms can be formed from a four-link mechanism through slight variation, such as changing the character of the pair, proportions of links, etc. Furthermore, many complex link mechanisms are combinations of two or more such mechanisms. The majority of four-link mechanisms fall into one of the following two classes:

1) The four-bar mechanism, and
2) The slider-crank mechanism

G. Working Principle of the Product Transport Mechanism

Crank and Lever Mechanism: Crank and Lever mechanism is selected for product transport mechanism for its simplicity, ease of operation and efficient performance. Figure 1 shows the schematic diagram of the mechanism. It consists of four links, the fixed frame, the crank and the two levers. In this mechanism, when crank OA rotates about the fixed centre O, the two horizontal levers oscillates about the fixed centre. This type of mechanism converts rotary motion into reciprocating motion.

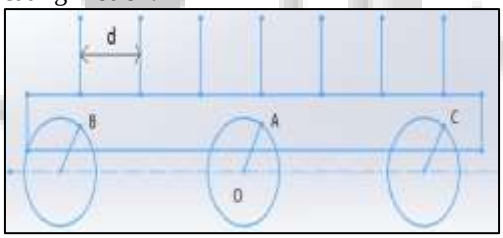

Fig. 1: Line Diagram of the proposed mechanism.

IV. METHODOLOGY

For completing all the processes for fabricating product transport mechanism, the following methodology is adopted.

- Analysis the problems in product transport mechanism.
- Designing the required components.
- Selection of materials required.
- Purchasing the materials.
- Fabrication of product transport mechanism.
- Testing of the product transport mechanism.

V. DETERMINING DEGREE OF FREEDOM

The minimum number of independent variables required to define the position and motion of the system is known as degree of freedom of the system.

In other words, degree of freedom is the number of input required to get constrained output in a chain.

According to Kutzback's equation

$$F = 3(L-1)-2J-H$$

Where,

F= Degree of freedom
L= Number of links
J= Number of binary joint
H= Number of higher pair

Hence,

$$F = 3(4-1) – 2x4 – 0$$
$$= 1$$

Here F = 1, then the mechanism can be driven by a single input motion.

VI. FABRICATION OF THE DESIGNED MECHANISM

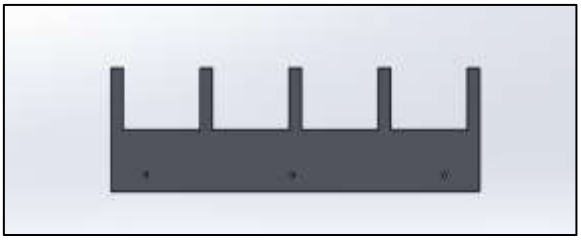

Fig. 2: Proposed design of main body on solid work.

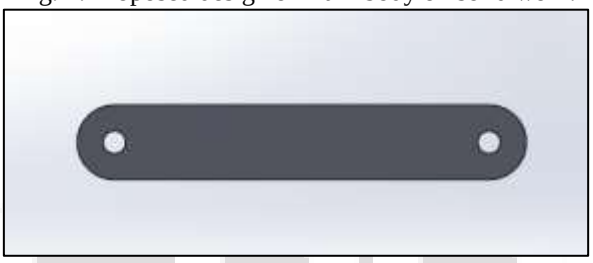

Fig. 3: Proposed design of crank on solid work.

VII. DC MOTOR SPEED CONTROL

A PWM circuit based on timer NE555 is the heart of the circuit. NE555 is wired as an astable multivibrator whose duty cycle can be adjusted by varying the POT R1. The output of IC1 is coupled to the base of transistor Q1 which drives the motor according to the PWM signal available at its base. Higher the duty cycle the average voltage across motor will be high which results in higher motor speed and vice versa. Change of DC motor direction is attained using the DPDT switch S1, which on application just toggle the polarity applied to the motor.

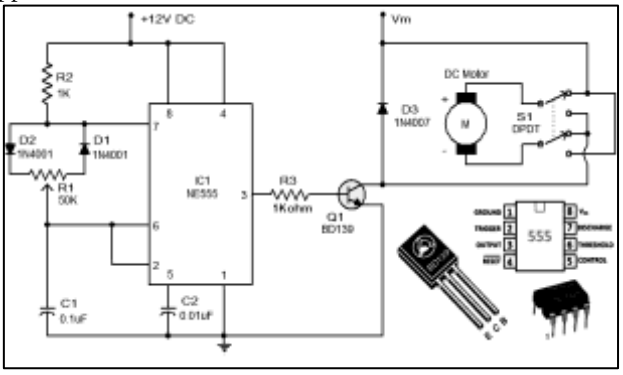

Fig. 4: Circuit diagram of DC motor speed control

- The circuit can be assembled on a vero board or PCB.
- Use 12 V DC for powering the IC.
- Vm is the power supply for motor and its value depends on the motors voltage rating. Any way maximum Vceo

for BD139 is 80V and so Vm should not be exceeded 80 volts.

– Maximum collector current BD 139 can be handle is 1.5A and so do not use a motor that consumes more than 1.5 amperes of current.

The 555 timer in bi-stable mode is also known as a flip – flop circuit. A flip – flop circuit alternates between two stable states, in this case the output of electrical current from the output pin. Unlike the mono – stable mode and astable modes, bi – stable mode doesn't need a resistor and capacitor to set the timing of the circuit. In fact there is no timing in this circuit. There are only two stable states (on and off) controlled directly by the trigger pin and reset pin.

Before going through the detailed explanation of 555 timer bi – stable multi – vibrator circuit, here is the short description about its PINs.

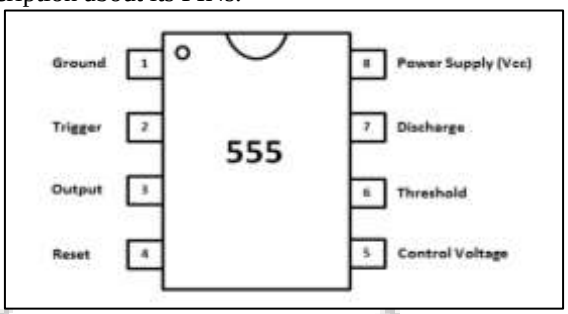

Fig. 5: NE 555

1) Pin 1 Ground: This pin should be connected to ground.
2) Pin 2 Trigger: Trigger pin is dragged from the negative input of comparator two. The Lower comparator output is connected to SET pin of flip – flop. A negative pulse (<Vcc/3) on this Pin sets the flip – flop and output goes high.
3) Pin 3 Output: This pin also has no special function. This is output pin where Load is connected. It can be used as source or sink and drive up to 200mA current.
4) Pin 4 Reset: There is a flip – flop in the timer chip. Reset pin is directly connected to MR (Master Reset) of the flip – flop. This is a active Low pin and normally connected to VCC for preventing Reset.
5) Pin 5 Control Pin: The control pin connected from the negative input pin of comparator one. Output pulse width can be controlled by applying voltage at this Pin, irrespective noise interference with the working.
6) Pin 6 Threshold: Threshold pin voltage determines when to reset the flip – flop in the timer. The threshold pin is drawn from positive input of upper comparator. If the control pin is open, then a voltage equal to or greater than VCC *(2/3) will reset the flip – flop. So the output goes low.
7) Pin 7 Discharge: This pin is drawn from the open collector of transistor. Since the transistor (on which discharge pin got taken, Q1) got its base connected to Qbar. Whenever the output goes low or the flip –flop reset, the discharge pin is pulled to ground and capacitor discharge.
8) Pin 8 Power or VCC: It is connected to positive voltage (+3.6V to 15V).

VIII. SPECIFICATION OF THE MACHINE

After making the final modification of the machine and from the final fabricated design the following specification of the machine are found out.

– Frame dimension = 30cm x 14cm x 16cm
– Length of lever = 20cm
– Product size = 8cm
– Rail distance = 7cm
– Distance between the two finger plates = 5cm
– Displacement of the product = 8cm
– Mechanism = Crank and Lever Mechanism
– Materials = MDF Teak wood
– Product translation = Step wise movement (delay between moving product)

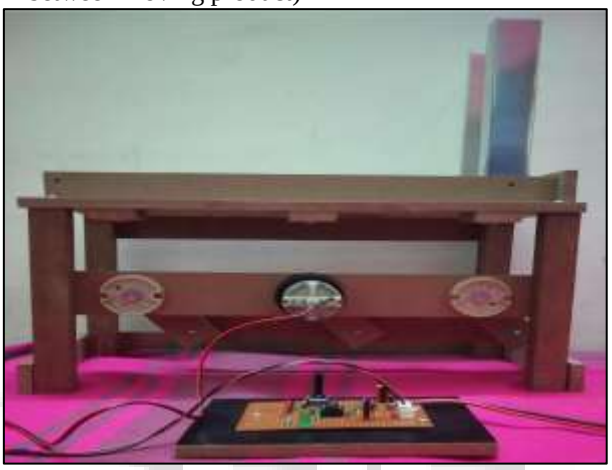

Fig. 6: Final fabricated design.

IX. ADVANTAGES AND FUTURE SCOPE

A. *Advantages*

The advantages are as follows:

1) Simple and efficient.
2) Reduce resource, i.e. working time.
3) Manufacturing cost is less and it is economical.
4) No noise pollution.
5) Consumes less energy.
6) Its environment friendly doesn't cause pollution.
7) Can be used for small scale industries.
8) It can create a balance line in the assembly line.

B. *Future scope*

1) With modification within the machine all type of products of varying load can be transported with the help of product transport mechanism.
2) Implementation for large industries is possible.
3) Can be fabricated for heavy products.

X. CONCLUSION

The product transport mechanism in an assembly line plays an important role in industries in minimizing the idle time of workers and increasing the total productivity of work. In this project, a product transport mechanism is designed, fabricated and tests successfully which can transport products in an assembly line from one to another for various operation is to be performed. Basic mechanical knowledge along with designing and technical skills are used for designing and

fabricating the project. The performance of the product transport mechanism is found to be satisfactory.

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