International Journal of Enhanced Research in Management & Computer Applications
ISSN: 2319-7471, Vol. 13, Issue 4, April-2024, Impact Factor: 8.285
Presented at "ICRETETM-2024", Organized by GSMCOE, Pune, on 22nd - 23rd April 2024

Design Development and Fabrication of Box Transfer Mechanism

Prof. Ramsing Thakur[1], Tanvir Mokashi[2], Mohammadali Mujawar[2], Naved Patel[2], Yasin Pathan[2]

[1]Assistant Professor, Department of Mechanical Engg, Genba Sopanrao Moze College of Engg. Pune -411048.
[2]UG Students of Genba Sopanrao Moze College of Engg.Pune-411048.

ABSTRACT

This paper presents a method whereby rotary motion is converted into reciprocating motion using a single slider crank mechanism. The primary aim of this prototype is to offer an alternative to traditional conveyor systems, one that is fully mechanical, highly efficient, and incurs low initial and maintenance costs. Targeting small-scale manufacturing plants and businesses, these mechanical conveyors focus on minimizing expenses. Unlike conventional conveyor systems that rely on belts and large input/output motors, this prototype operates solely on a four-bar mechanism and utilizes a simple rotary motor. By converting rotary motion to reciprocating motion, this prototype aims to streamline operations for small-scale industries, reducing their workload significantly. The project is related to the modification in the existing mechanism.

Index Terms –box transportation, slider crank mechanism, DC motor, four bar mechanism.

INTRODUCTION

The mechanism for moving or shifting boxes employs a simple setup, operated through a crank and linkage arrangement. Electric motor power facilitates the conversion of rotary motion into back-and-forth movement of the linkages, making the process straightforward. By utilizing cranks and mechanical linkages, rotary motion is translated into linear motion. While the conveyor system can operate continuously, introducing a timed delay necessitates expensive software programming. Hence, a basic module for moving packages with an embedded time delay is devised, offering flexibility for package adjustments or other purposes. As shown in Figure 1.

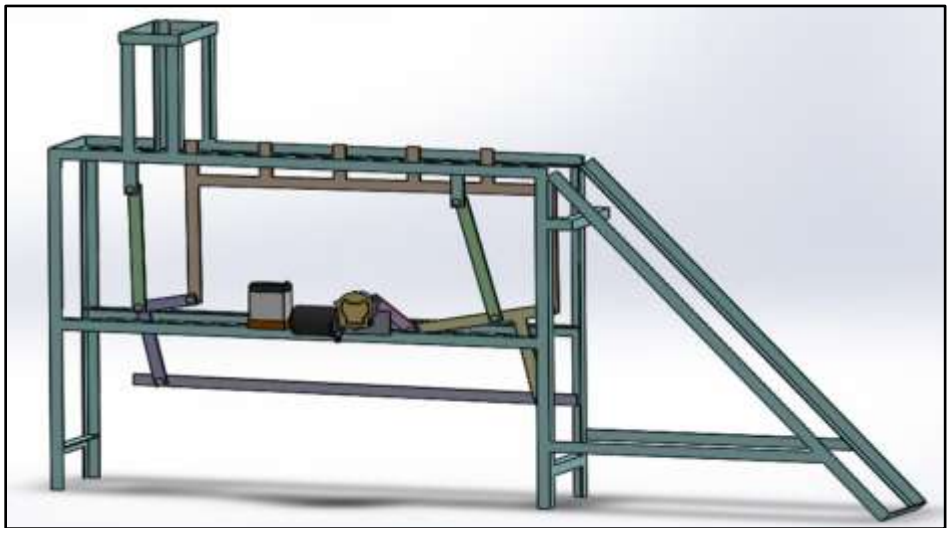


Figure 1. Box Transfer Mechanism

LINKAGE MECHANISM: A linkage mechanism is created by joining two or more levers together. These linkages are engineered to alter the force's direction or synchronize the movement of multiple objects. Various fasteners like pins, end-threaded bolts with nuts, and loosely fitted rivets are utilized to connect linkages while enabling their free movement. Generally, linkages fall into two categories: simple planar linkages and more intricate specialized linkages. Both types are capable of accomplishing specific tasks.

CRANK MECHANISM FOR BOX TRANSPORT MECHANISM: The crank-rocker mechanism used in box transport systems is a basic yet highly functional setup. It's composed of rigid bodies and lower pairs, as defined by Hunt (1978). In planar mechanisms, lower pairs are either revolute (allowing rotational motion) or prismatic (permitting linear motion). The simplest closed-loop linkage, the four-bar linkage, consists of four members: three moving links and one fixed link, all connected by four pin joints. It's worth noting that any mechanism with at least one fixed link qualifies as a linkage.

SOME IMPORTANT CONCEPTS IN LINK MECHANISMS:

1. Crank: A side link that rotates relative to the frame is termed a crank.
2. Rocker: Any link that remains stationary and does not rotate is referred to as a rocker.
3. Crank-rocker mechanism: Within a four-bar linkage, when one shorter side link rotates and the other oscillates, it forms a crank-rocker mechanism.
4. Double-crank mechanism: Within a four-bar linkage, if both side links rotate, it constitutes a double-crank mechanism.
5. Double-rocker mechanism: In a four-bar linkage, if both side links oscillate without rotation, it is termed a double-rocker mechanism.

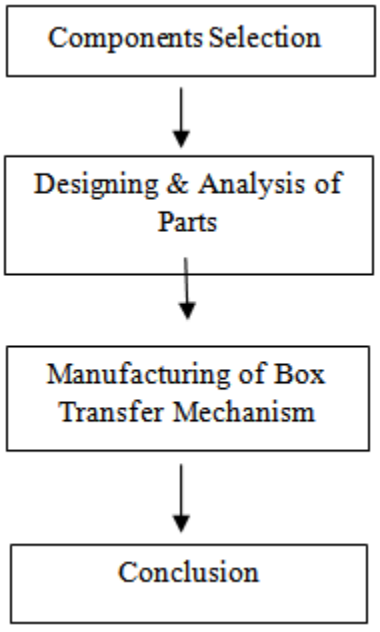
PUSH-PULL LINKAGE: The box moving mechanism has a simple mechanism and is operated with a crank and linksarrangement.HeretheelectricmotorrotarymotionisconvertedintotheToand Fro motionorlinearmotionofthelink.Theoutput link moves in the same direction as the input link. Technically classed as an eight-bar linkage, it can be rotated through 360° without changing its function. The rotary motion is converted into linear motion by the crank and mechanical link ages arrangement.

LITERATURE REVIEW

U.patilet.al., [1] This paper details the development of a box transportation device, alongside instruction in lathe machine usage and safety procedures. Through the integration of kinematics links and a motor, effectively engineered a functioning shifting mechanism, showcasing the practical application of fundamental mechanical concepts. Future adjustments to the prototype may improve its effectiveness and adaptability for various industrial settings. J.Eswaret.al., [2]This paper presents a novel approach to converting rotary motion into reciprocating motion using a single slider crank mechanism, aiming to replace conventional conveyor systems with mechanically efficient alternatives for small-scale manufacturing. SandeshShindeet.al., [3] This document presents a detailed exploration of the development, design, and functionality of a Box Transporting Machine, highlighting its advantages over traditional conveyor systems and its potential impact on industrial processes. It provides valuable insights into the construction and operation of linkage mechanisms, emphasizing their significance in facilitating intermittent motion and package movement. Additionally, it discusses potential modifications to enhance the efficiency of the mechanism and concludes with the successful implementation of basic mechanical knowledge and design skills in the project. Rajesh Kumar et.al., [4] The document outlines the creation of a mechanical system for intermittent package movement in industries, offering advantages over conveyor systems by allowing stop-and-move motion. The prototype, comprising an electric motor, shafts, and a fabricated frame, accommodates packages up to 2 KGs and integrates with quad staying machines for folding or setting up box blanks. The discussion extends to automation's benefits, including task simplification and enhanced capabilities, alongside considerations such as initial costs and limitations. Detailed specifications, functional descriptions, and fabrication insights underscore the mechanism's versatility and practicality across industries, serving as a valuable resource for understanding its implementation and design nuances.M.Viswanathet.al.,[5]The box moving or shifting setup has a simple mechanism, operated with crank and links arrangement As by the electric motor rotary motion is converted into the To and Fro motion of the linkages, it takes very simple. The rotary motion is converted into linear motion by the crank and mechanical linkages arrangement. The conveyor system is either continuous movement or if the time delay is to be produced there will be definite requirement of software programming which will be costly. So a basic module of moving packages is designed with time delay which can be used to do alterations if required in the package or move the package for anyotherpurpose.P.R.Kothule.al.,[6] The document discusses the design and fabrication of a box moving mechanism using mechanical linkages for intermittent movement of packages in industries. The mechanism is operated with a crank and links

arrangement, converting rotary motion into linear motion to shift boxes. The system includes a DC motor, and the mechanism is made of mild steel and wood. The aim is to create a mechanism that can move heavy packages. The advantage of this system over a conveyor system is the ability to introduce time delays between moving packages for alterations or other purposes. The principle of box moving is to change the circular motion of the DC motor into translational motion with the help of levers and linkages through metal connecting rods. The document also discusses the concept, principle, advantages, and specifications of the mechanism. Haris Khan et al.[7] present a box transfer system featuring a simple yet effective mechanism driven by a combination of chains and gear cranks. The system employs an electric motor to convert rotational motion into linear movement through shaft linkages, facilitated by the chain and gear crank arrangement. Notably, the wiper motor commonly found in cars is repurposed to drive the main frame via linkages within this mechanism. MandarParamaneet.al., [8] In today's era of automation and mass production for industries to be competitive and cost effective we tried to find a solution for packaging industries. As there are number of items required in day-to-day life like soaps, confectioneries, automobile components, food items are produced in small and medium scale industries. For packaging these items using labor is quite costly affair and even production output is limited due to human abilities and there are some human errors too. So, we have tried to find the best feasible working solution for this kind of industries. Also, we have considered the cost angle for the small and medium sized industries. We have analyzed the change in output and overall performance of this machine. A.Vijayet.al., [9] The construction of a box shifting mechanism involves assembling several components including hylem board, DC wiper motor, DC battery, steel stand, and wooden pieces. The steel frame is created using rectangular hollow pipes and steel rods, which are joined together through welding. Hylem boards are shaped through cutting operations. The DC wiper motor is mounted onto the frame using bolt and nut connections. Power is supplied from a 12-volt, 7-amp DC battery through copper wires. The connections between components are conceptualized to allow for ideal movement, such as pure rotation or sliding, and are referred to as joints.Karthick.Set.al., [10] In an organizational context, Manufacturing holds significant importance, thus our project centers on the "design and construction of a box transport machine." The mechanism for moving or shifting boxes entails a straightforward setup, employing a crank and lever system. The rotational force generated by the motor activates the links, facilitating the back-and-forth motion of the teeth. This rotational force is converted into linear motion through the arrangement of cranks and mechanical linkages. The conveyor system operates either continuously or, if a time delay is necessary, software programming becomes essential, incurring additional costs. Therefore, a fundamental module for moving packages with a built-in time delay has been devised, allowing for adjustments to the package or movement for various purposes. This system achieves the transfer and shifting of boxes using elementary mechanical principles.

METHOLDOLOGY



Selection of components:

- MS Frame
- Shaft
- Linkages
- Pulley
- Bushes
- Fasteners
- Battery

A four-bar linkage is a basic movable closed chain mechanism with four bodies connected by joints. Bennet's linkage is a specific type with angled joints for mobility. The project combines a Box Shifting Mechanism and Gearless Power Transmission Mechanism. Circular plates with drilled holes are connected by three bent links at a 90° angle. Power applied to the driver shaft rotates the first plate, transferring power through the links to the second plate and then to the upper structure.

MANUFACTURING

Main components are used to manufacture Box Transfer Mechanism:

- MS Frame
- Shaft
- Linkages
- Pulley
- DCMotor
- Battery 12V
- Fasteners

MS Frame:

The frame component consists of one piece of M.S. angle. Initially, it is cut into the desired length according to the drawing using a gas cutting machine and a steel rule. Then, the angle is further cut into the required number of pieces using the same equipment. Following this, filing operations are conducted on the cut sides to ensure perpendicularity, utilizing a bench vice, file, and try square. The angles are then welded to achieve the specified size, with alignment checked using a try square. Finally, the frame is drilled at designated points as per the drawing using a radial drill machine, twist drill, and vernier caliper for precision measurement.

Figure 2. MS Frame

Shaft:

The process of crafting a steel shaft involves marking, cutting, and facing on a lathe machine. Precision measurements are taken throughout the process using a scale and vernier caliper. Keyways are milled on the ends with a milling machine, and filing operations ensure smoothness.

Figure 3. Shaft

Linkages:

In the manufacturing of linkages for a box transfer mechanism, precision is crucial. The process typically involves cutting, shaping, and assembling various components to ensure smooth and efficient operation. Close attention is paid to tolerances and alignment during fabrication. Quality control measures, including rigorous testing and inspection, are implemented to guarantee the reliability and functionality of the linkages.

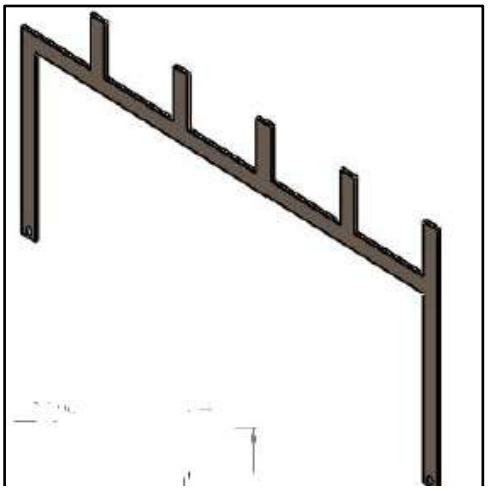


Figure 4. Shaft

Pulley:

For the production of two cast iron pulleys, the process involves facing both sides of the hub on a lathe machine, boring the inner diameter to match the shaft size, drilling holes in the hub as per specifications, and tapping the drilled areas. Measurements are ensured with a vernier caliper, and the entire process takes around 55 minutes.

Bushes:

The production of two M.S. slide bushes involves marking and cutting the pipe to size using a power hacksaw, facing and turning on a lathe machine, filing both ends, and drilling holes as per specifications. Measurements are taken with a vernier caliper at each step.

Figure 5. Bushes

Battery 12v:

Batteries typically supply electric power to various electronic devices like bulbs, motors, and are commonly found in automobiles for functions like horn and self-start mechanisms. In this setup, the battery powers the motor, enabling its operation, and it can be recharged for repeated use.

DC Motor:

The DC motor finds widespread application in various machine setups. In this chain and crank mechanism, it drives the main frame through linkages. The motor's specifications are 12 volts, 15 watts, and 20 revolutions per minute (rpm), allowing for speed regulation from fast to slow. Its role is to provide intermittent motion.

Figure 6. DC Motor

Experimentation:

- Prepare drawing for the machine transporter.
- Cut iron angles to specified measurements using a cutting machine and weld them according to the drawing.
- Weld the iron angles to create the bed for the machine.
- Cut mild steel plate to the required length for the box transport machine.
- Shape the plate using a lathe machine to form shafts, hangers, and cranks as per dimensions provided.
- Drill holes in the prepared shafts, hangers, and cranks according to the drawing.
- Prepare the shaft for moving boxes to the next level by cutting mild sheet plate, attaching edges with welding, and smoothing with a file.
- Fix the electric motor onto the bed of the machine at the designated position.
- Attach the crank to the motor on one side and to shaft 1 on the other side.
- Connect the hanger link to shaft 1 and shaft 2.
- Attach both shafts to the transporting shaft.
- Attach two additional hanger links to the shafts.
- Fix the other two hanger links and transporting shaft to the top of the bed using bearing gear.
- The box transporting machine is now assembled.
- Test the machine by supplying current to the electric motor and placing boxes on top for testing purposes.

CALCULATION

Power of motor = 15 N- m /s
Rpm of motor = 20 rpm
CALCULATION FO FINAL SPEED & TORQUE
Power of motor= P = 15 watt.
$P = 2\pi NT/60$
Were,
N→ Rpm of motor = 20 rpm
T →Torque transmitted$15 = 2\pi \times 20 \times T/60$
T = 7.16 N-m
T = 7161.9 N-mm
Calculation of force generated to shift the box.
Now, length of link between motor and 1200mm link is 155mm

T = F x R
F = 7162/155 = 46.20 N = 4.71 kg
Motor efficiency be 50% percent
F = 14 N = 1.5 kg
So, design is safe
Speed of box shifting
Diameter of link is 0.155 m
V= πDN/60
V = 3.142 x 0.155 x 20 / 60
V = 0.16 m/s
1 m/s = 3.6 km/hr
So,V = 0.584 km/hr
CHECKING THE FAILURE OF LINK UNDER BENDING LOAD
F = maximum force applied = 46.2 x 2 = 92.4 N
For simply supported beam, M = F x L/4
M = 92.4 x 1200/4 = 27720 N-mm
And section modulus = Z = 1/6 bh2
Z = 1/6 x 3x302
Z = 1/6 x 2700
Z = 450 mm3.
Now using the relation,
Fb = M / Z
Fb= 27720 / 450 = 61.6 N/mm2
Induced stress is less then allowable 260 N/mm2 so design is safe.

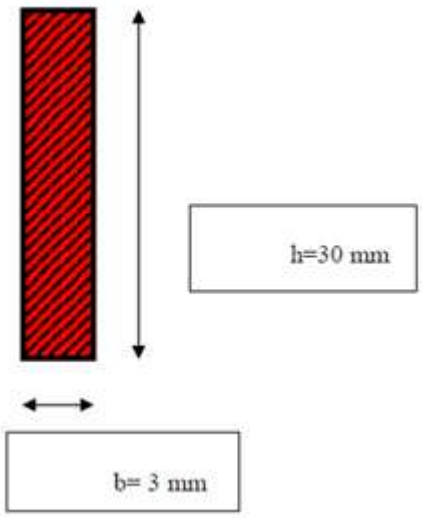


Figure 7. Linkage

RESULT

The Box Transport Mechanism Project involves a system designed to move packed goods individually, allowing for various actions like inspection, sealing, labeling, etc., during transit. This system moves the goods one by one using bar linkages. The entire mechanism is constructed from mild steel. Several linkages are employed to advance the box, with the primary linkage connected to the motor, which converts rotary motion into linear motion, facilitating movement for the shifter links.

CONCLUSION

The Box Transport Mechanism Project utilizes a systematic approach to construct a machine capable of individually transporting packed goods for various tasks such as inspection, sealing, and labeling during transit. The process involves precise steps, from preparing the drawing and cutting iron angles to shaping mild steel plates into essential components like shafts, hangers, and cranks. These components are meticulously assembled, with the primary linkage connected to the electric motor, enabling the conversion of rotary motion into linear motion for efficient box movement. The entire mechanism is constructed from mild steel for durability. Through careful testing, the functionality of the machine is verified, ensuring its effectiveness in facilitating the transportation and handling of goods.

REFERENCES

[1]. Ulhaspatil, Tejas Kale, Parag Lokhande proposed by "BOX TRANSFER MECHANISM" International Journal of Innovations in engineering and science (IJIES) ISSN: 2456-3463X | 2021.

[2]. J.Eswar, A.Abhishek, G. TulsiRam, A.Nagaraju, K.Bhargavi proposed by"FABRICATION OF PUSH BOX WITH KINEMATIC LINK MECHANISM",International Journal of Creative Research Thoughts(IJCRT) ISSN 2320 – 2882, Impact Factor- 3.145, March 2023.

[3]. SachinShindeSachinJaid,AkshayJaid,NiteshWaykar proposed by "BOX TRANSFER MACHINE", International Journal of Engineering Science And Management, FEBRUARY 2016 ISSN (2277-5528)

[4]. Hitesh Patil, Rajesh Kumar proposed by "PUSH BASED BOX TRANSFER MECHANISM,",International Journal Of Interdisiplinary Innovative Research And Development (JIIRD) Vol.01, Special Issue 02/2015.

[5]. SyafiqahM,ViswanathV,S.Madhanraj,S.Manibharathy,N.Balakrishnan,proposedby"BOX TRANSFERMECHANISM, THROUGH KINEMATIC LINK", International Journal of Engineering Research & Technology (IJERT) ISSN: 2278- 0181Published by, www.ijert.org Conference Proceeding Special Issue – 2018.

[6]. P.R.Kothule, M.Chavan, S.P Bhaleraopropsed "BOX TRANSFER MECHANISM, THROUGH KINEMATIC LINK", International Conference On science Technology And Management ISBN- 978-93-86171-30-6.

[7]. FathimaParveen, Haris khan A, KancharlaGireesh, KosuruHemanth, proposed by "BOX TRANSFERATION USING CHAIN AND GEAR CRANK MECHANISM" International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395 -0056 ,Volume: 04 Issue: 06 | June - 2017, www.irjet.net ,p-ISSN: 2395-0072..

[8]. MandarParamane, Omkar Kore, AbhijeetPethkar, RohitKandale, proposed by "DESIGN & ANALYSIS OF BOX TRANSFER MECHANISM", International Journal of Electrical and Electronics Engineers ,Volume 14.Issue No.01.Jan-June 2022..

[9]. Radu A, A. Vijay, N. Sivakumar, M. Prabhu, and R. Rathish proposed by "DESIGN AND FABRICATION OF INDUSTRIAL CONVEYOR USING CRANK MECHANISM", International Journal of Innovation and Scientific Research, ISSN 2351-8014, Vol. 30 No. 3 May 2017, page no. 535- 539.

[10]. Karthick, Ajith Kumar , Chidambaram , Gopinath , Harish Kumar proposed by "DESIGN AND BOX TRANSFER MACHINE", International Journal of Innovative Research in Technology, Volume 4, Issue11,ISSN:2349-6002,April 2018