Design and Fabrication of Industrial Conveyor Using Crank Mechanism

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Abstract - ***This machine is basically works on the principle of Single Slider Crank Mechanism. Which is the heart of this machine and it converts rotary motion into a reciprocating motion. Here Fabricated the conveyor using crank mechanism machine, this project can be utilized in industry. Industries in worldwide use conveyors as a mechanism to transport boxes from place. This mechanism do not includes strong belts, pulleys and heavy motors to rotate the pulley to move the conveyor. As an alternative to this conveyor type, more simple and comfortable machine using four bar mechanism can be used. This box shifting machine helps in transfer of boxes smoothly by use of four bars with a simple arrangement. The four bar mechanism includes four links. One link is fixed and the other links act as crank, follower and connecting rod. The rotary motion of the crank is transferred to the follower by using connecting rod and is converted to the same rotary motion. This machine requires an electric motor to provide input to the system.***

Key words *:Crank mechanism, crank unit, inertia force balance, Material handling,*
Productivity.

1 INTRODUCTION

There has been a serious demand for intermittent movement of packages in the industries right from the start. Though the continuous movement is more or less important in the same field the sporadic motion has become essential .The objective of our project is to produce a mechanism that delivers this stop and move motion using mechanical linkages. The advantage of our system over the conveyor system is that the system has a time delay between moving packages and this delay can be used to introduce any alterations in the package or move the package for any other purpose and likewise. While 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 packages are moved is fabricated. All the links are being made of Aluminium which reduces the weight of the whole system including the head which has a direct contact with the boxes being moved. The system is expected to move as heavy packages as 2 to 3kgs approximately.

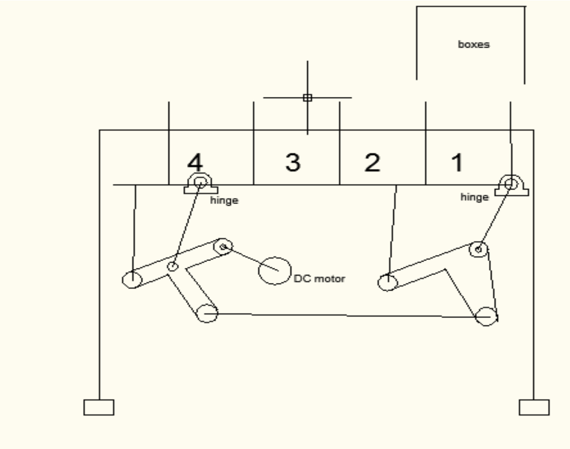

Fig-1: Crank rocker mechanis

DEFINITION

This machine is basically works on the principle of Single Slider Crank Mechanism which is the heart of this machine and it converts rotary motion into a reciprocating machine to crush the Cans/Plastic bottles. In this, link 1 is fixed and link 2 which is a crank is rotating about fixed link 1 and converts this rotary motion into the reciprocating motion of slider (corresponds to the link 4) by means of connecting rod which corresponds to the link 3. This is the inversion of single slider crank which is obtained by fixing link.

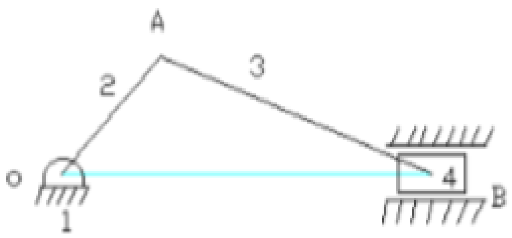

Fig-2: Single slider crank mechanism

About material Handling Starting from the time, raw material enters the factory gate and goes out of the factory gate in the form of finished products, it is handled at all stages between, no matter it is in stores or on shop floor. It has been estimated that average material handling cost is roughly 20 to 60 % of the total cost. It thus, becomes clear that the cost of production of an item can be lowered considerably by making a saving in the material handling cost.

2 LITERATURE REVIEW

2.1 Linkage Mechanism

A linkage is a mechanism formed by connecting two or more levers together. Linkages can be designed to change the direction of a force or make two or more objects move at the same time. Many different fasteners are used to connect linkages together yet allow them to move freely such as pins, end-threaded bolts with nuts, and loosely fitted rivets.

There are two general classes of linkages: simple planar linkages and more complex specialized linkages; both are capable of performing tasks such as describing straight lines or curves and executing motions at differing speeds. The names of the linkage mechanisms given here are widely but not universally accepted in all textbooks and references.Linkages can be classified according to their primary functions:

Function generation: the relative motion between the links connected to the frame

Path generation: the path of a tracer point

Motion generation: the motion of the coupler linkage.

2.2 Slider Mechanism

Common to most reciprocating engines is a linkage known as a crank-slider mechanism. Diagrammed in Figure.5, this mechanism is one of several capable of producing the straight-line, backward-and-forward motion known as reciprocating. Fundamentally, the crank-slider converts rotational motion into linear motion, or viceversa.With a piston as the slider moving inside a fixed cylinder, the mechanism provides the vital capability of a gas engine: the ability to compress and expand a gas. Before delving into this aspect of the engine, however, let us examine the crank-slider mechanism more closely.

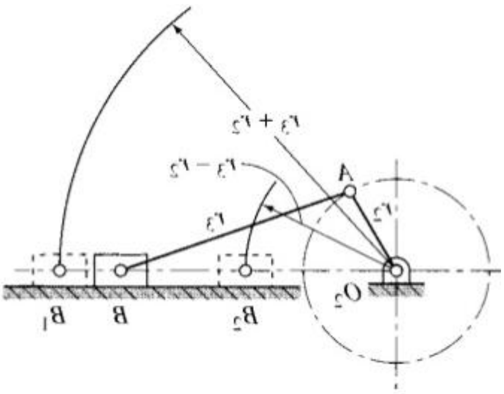

Fig-3: Slider crank mechanism

It is evident from Figure-3, that, while the crank arm rotates through 180°, the piston moves from the position known as top-center (TC) to the other extreme, called bottom-center (BC). During this period the piston travels a distance, S, called the stroke, which is twice the length of the crank.For an angular velocity of the crank (ω) the crank pin A has a tangential velocity component ω S/2. It is evident that, at TC and at BC, the crank pin velocity component in the piston direction, and hence the piston velocity, is zero. At these points, corresponding to crank angle = 0° and 180°, the piston reverses direction. Thus as varies from 0° to 180°, the piston velocity accelerates from 0 to a maximum and then returns to 0. A similar behavior exists between 180° and 360°.The connecting rod is a two-force member; hence it is evident that there are both axial and lateral forces on the piston at crank angles other than 0° and 180°. These lateral forces are, of course, opposed by the cylinder walls. The resulting lateral force component normal to the cylinder wall gives rise to frictional forces betweenthe pistons rings and cylinder. It is evident that the normal force, and thus the frictional force, alternates from one side of the piston to the other during each cycle. Thus the piston motion presents a challenging lubrication and reduction of both wear and energy loss.

The position of the piston with respect to the crank centerlineproblem for the control is given by

x = (S/2) cos + Lcos Ø [ft | m] ……. (1)

where, yA = (S/2) sin = L sinØ can be used to eliminate Ø to obtain

X/L = (S/2L) cos + [1- (S/2L)si n] ½

Thus, while the axial component of the motion of the crank pin is simple harmonic, XA= (S/2) cos ,the motion of the piston and piston pin is more complex.

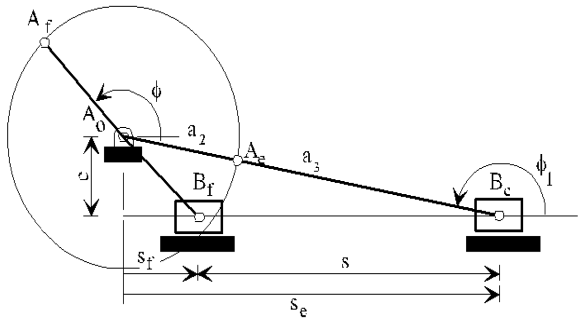

Fig-4: Geometry and notation for the crank slider

It may be seen from Equation (2), however, that as S/L becomes small, the piston motion approaches simple harmonic. This becomes physically evident when it is recognized that, in this limit, the connecting rod angle 'Ø' approaches 0 and the piston motion approaches the axial motion of the crank pin. Equations (1) and (2) may be used to predict component velocities, accelerations, and forces in the engine. The volume swept by the piston as it passes from TC to BC is called the piston displacement, disp. Engine displacement, DISP, is then the product of the piston displacement and the number of cylinders, DISP = (n)(dips). The piston displacement is the product of the piston cross-sectional area and the stroke. The cylinder inside diameter (and, approximately, also the piston diameter) is called its bore. Cylinder bore, stroke, and number of cylinders are usually quoted in engine specifications along with or instead of engine displacement. It will be seen later that the power output of a reciprocating engine is proportional to its displacement. An engine of historical interest that also used the crank-slider mechanism.It may be seen from Equation (2), however, that as S/L becomes small, the piston motion approaches simple harmonic. This becomes physically evident when it is recognized that, in this limit, the connecting rod angle 'Ø' approaches 0 and the piston motion approaches the axial motion of thecrank pin. Equations (1) and (2) may be used to predict component velocities, accelerations, and forces in the engine. The volume swept by the piston as it passes from TC to BC is called the piston displacement, disp. Engine displacement, DISP, is then the product of the piston displacement and the number of cylinders, DISP = (n)(dips). The piston displacement is the product of the piston cross-sectional area and the stroke. The cylinder inside diameter (and, approximately, also the piston diameter) is called its bore. Cylinder bore, stroke, and number of cylinders are usually quoted in engine specifications along with or instead of engine displacement. It will be seen later that the power output of a reciprocating engine is proportional to its displacement.Anengine of historical interest that also used the crankmechanism is discussed in the next section.

2.3 Double Crank Mechanism

Double crank mechanism: The mechanism of coupling rod of a locomotive which consist of four links as shown in figure-5. In this mechanism, the links AD and DC (having equal lengths) act as cranks and are connected to the respective wheel. The links CD acts as a coupling rod and the link AB is fixed in order to maintain a constant center to center distance between them. This mechanism is meant for transmitting rotary motion from one wheel to other wheel.

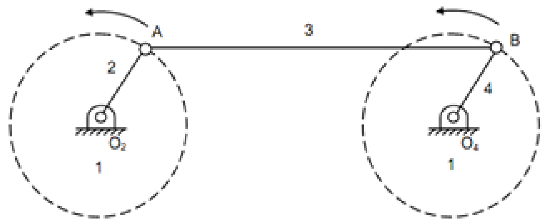

Fig-5: Double crank mechanism

2.4 Simple Planar Linkages

a)Reverse-motion linkage

Fig-6a, can make objects or force move in opposite directions; this can be done by using the input link as a lever. If the fixed pivot is equidistant from the moving pivots, output link movement will equal input link movement, but it will act in the opposite direction. However, if the fixed pivot is not cantered, output link movement will not equal input link movement. By selecting the position of the fixed pivot, the linkage can be designed to produce specific mechanical advantages. This linkage can also be rotated through 360°.

b)Push-pull linkage

Fig-6b, can make the objects or force move in the same direction; the output link moves in the same direction as the input link. Technically classed as a four-bar linkage, it can be rotated through 360° without changing its function.

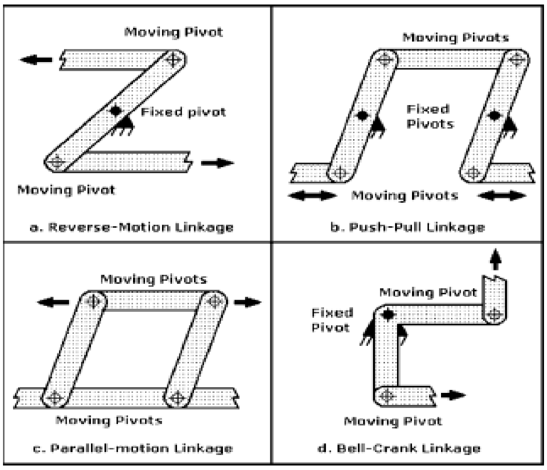

Fig-6: Functions of four basic planar linkage mechanism

C)Parallel-motion linkage

Fig-6c,can make objects or forces move in the same direction, but at a set distance apart. The moving and fixed pivots on the opposing links in the parallelogram must be equidistant for this linkage to work correctly. Technically classed as a four-bar linkage, this linkage can also be rotated through 360° without changing its function. Pantographs that obtain power for electric trains from overhead cables are based on parallel-motion linkage. Drawing pantographs that permit original drawings to be manually copied without tracing or photocopying are adaptations of this linkage; in its simplest form it can also keep tool trays in a horizontal position when the tool box covers are opened.

d)Bell-crank linkage

Fig-6d,can change the direction of objects or force by 90°. This linkage rang doorbells before electric clappers were invented. More recently this mechanism has been adapted for bicycle brakes. This was done by pinning two bell cranks bent 90° in opposite directions together to form tongs. By squeezing the two handlebar levers linked to the input ends of each crank, the output ends will move together. Rubber blocks on the output ends of each crank press against the wheel rim, stopping the bicycle. If the pins which form a fixed pivot midpoints of the cranks, link movement will be equal. However, if those distances vary, mechanical advantage can be gained.

2.5 Crank-Rocker Mechanism For Product Transport

The four bar linkage is the simplest and often times, the most useful mechanism. As we mentioned before, a mechanism composed of rigid bodies and lower pairs is called a linkage (Hunt 78). In planar mechanisms, there are only two kinds of lower pairs and revolute pairs and prismatic pairs.The simplest closed-loop linkage is the four bar linkage which has four members, three moving links, one fixed link and four pin joints. A linkage that has at least one fixed link is a mechanism.This mechanism has four moving links. Two of the links are pinned to the frame which is not shown in this picture. In SimDesign, links can be nailed to the background thereby making them into the frame.

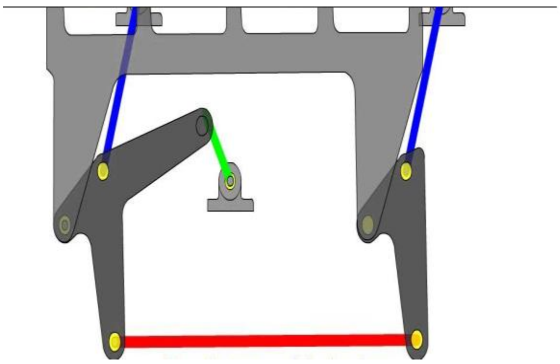

Fig-7:Crank rocker mechanism

How many DOF does this mechanism have? If we want it to have just one, we can impose one constraint on the linkage and it will have a definite motion. The four bar linkage is the simplest and the most useful mechanism.

Reminder: A mechanism is composed of rigid bodies and lower pairs called linkages (Hunt 78). In planar mechanisms there are only two kinds of lower pairs: turning pairs and prismatic pairs.

2.6 Function of Linkage

The function of a link mechanism is to produce rotating, oscillating, or reciprocating motion from the rotation of a crank or vice versa(Ham et al. 58). Stated more specifically linkages may be used to convert:

1. Continuous rotation into continuous rotation, with a constant or variable angular velocity ratio.

2. Continuous rotation into oscillation or reciprocation (or the reverse), with a constant or variable velocity ratio.
3. Oscillation into oscillation, or reciprocation into reciprocation, with a constant or variable velocity ratio.

Linkages have many different functions, which can be classified according on the primary goal of the mechanism:

1. **Function generation:** the relative motion between the links connected to the frame,
2. **Path generation:** the path of a tracer point, or
3. **Motion generation:** the motion of the coupler link.

2.7 Four Link Mechanisms

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 variations, such as changing the character of the pairs, 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 linkage mechanism, and the slider-crank mechanism.

Definitions: In the range of planar mechanisms, the simplest group of lower pair mechanisms are four bar linkages. A four bar linkage comprises four bar-shaped links and four turning pairs as shown.

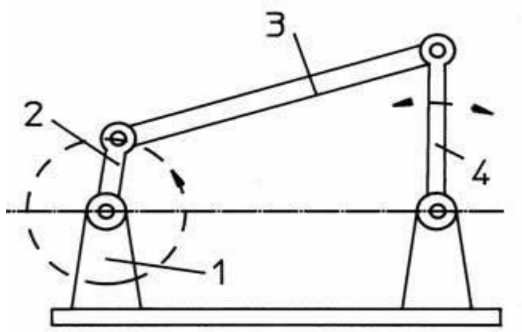

Fig-8: four bar crank mechanism

The link opposite the frame is called the coupler link, and the links which are hinged to the frame are called side links. A link which is free to rotate through 360 degree with respect to a second link will be said to revolve relative to the second link (not necessarily a frame).

If it is possible for all four bars to become simultaneously aligned, such a state is called a change point.

Some important concepts in link mechanisms are:

1. Crank: A side link which revolves relative to the frame is called a crank.
2. Rocker: Any link which does not revolve is called a rocker.
3. Crank-rocker mechanism: In a four bar linkage, if the shorter side link revolves and the other one rocks (i.e., oscillates), it is called a crank-rocker mechanism.
4. Double-crank mechanism: In a four bar linkage, if both of the side links revolve, it is called a double-crank mechanism.

5. Double-rocker mechanism: In a four bar linkage, if both of the side links rock, it is called a double-rocker mechanism.

2.8 Classification

Before classifying four-bar linkages, we need to introduce some basic nomenclature.In a four-bar linkage, we refer to the line segment between hinges on a given link as a **bar** where:

1. s = length of shortest bar
2. l = length of longest bar
3. p, q = lengths of intermediate bar

Grashof's theorem:It states that a four-bar mechanism has at least one revolving link if,$s + l <= p + q$ (5-1).And all three mobile links will rock if,$s + l > p + q$(5-2). The inequality is Grashof's criterion.All four-bar mechanisms fall into one of the four categories listed in Table 1.

From Table,1 we can see that for a mechanism to have a crank, the sum of the length of its shortest and longest links must be less than or equal to the sum of the length of the other two links. However, this condition is necessary but not sufficient. Mechanisms satisfying this condition fall into the following three categories:

1. When the shortest link is a side link, the mechanism is a crank-rocker mechanism. The shortest link is the crank in the mechanism.
2. When the shortest link is the frame of the mechanism, the mechanism is a double-crank mechanism.
3. When the shortest link is the coupler link, the mechanism is a double-rocker mechanism.

Table-1:Classification of Four-Bar Mechanism

Case	l + s versus p + q	Shortest Bar	Type
1	<	Frame	Double-crank
2	<	Side	Rocker-crank
3	<	Coupler	Double rocker
4	=	Any	Change point
5	>	Any	Double-rocker

2.9 Transmission Angle

In Figure-9, if AB is the input link, the force applied to the output link, CD, is transmitted through the coupler link BC. (That is, pushing on the link CD imposes a force on the link AB, which is transmitted through the link BC.) For sufficiently slow motions (negligible inertia forces), the force in the coupler link is pure tension or compression (negligible bending action) and is directed alongBC. For a given force in the coupler link, the torque transmitted to the output bar (about point D) is maximum when the angle βbetween coupler bar BC and output bar CD is $\pi/2$. Therefore, angle BCD is called transmission angle.

$$\alpha_{max} = |90^\circ - \beta|_{min} < 50^\circ$$

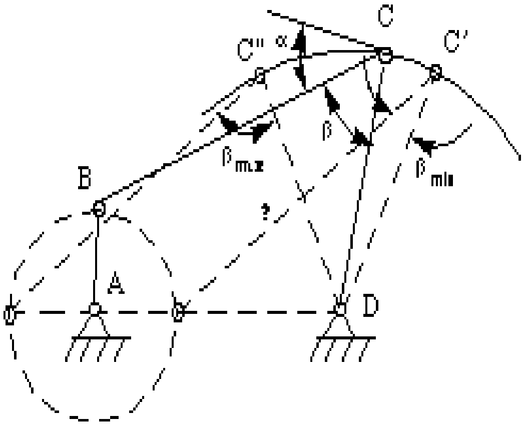

Fig-9: Transmission angle

When the transmission angle deviates significantly from π/2, the torque on the output bar decreases and may not be sufficient to overcome the friction in the system. For this reason, the **deviation angle** $\alpha=|\pi/2-\beta|$ should not be too great. In practice, there is no definite upper limit for α, because the existence of the inertia forces may eliminate the undesirable force relationships that is present under static conditions.

3 PROJECT FABRICATION

3.1 Material And Tools

3.1 .1 Box Transport Mechanism

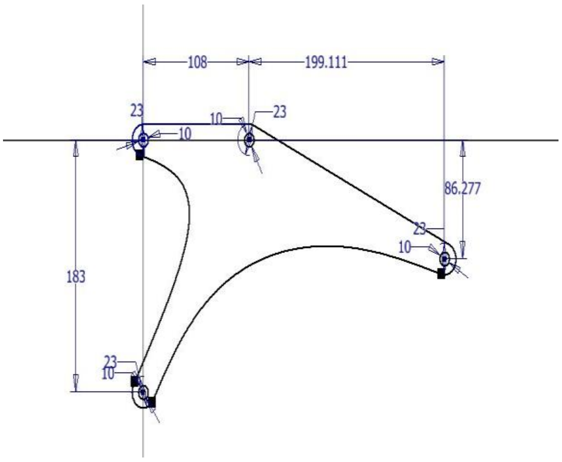

Fig-10: Design of Shaft 1

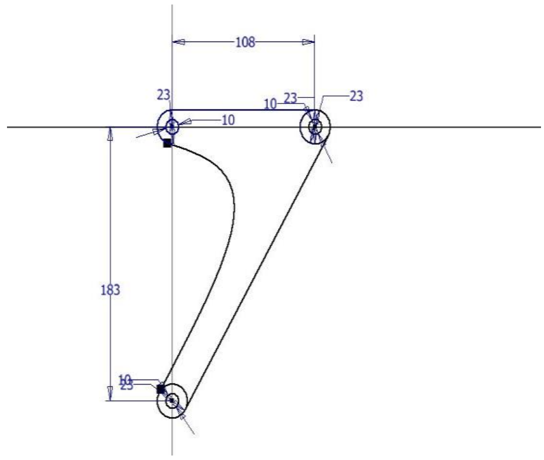

Fig-11: Design of Shaft2

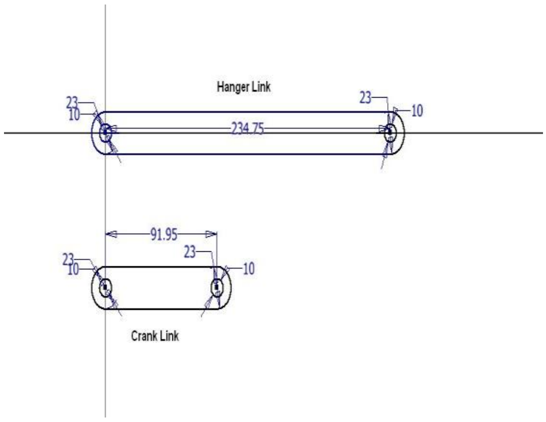

Fig-12: Design of Hanger and crank

3.1.2 Selection Of Materials

The design and fabrication of box shifting mechanism constructed by various components such as hylem board, dc wiper motor, dc battery, steel stand and wooden pieces. In this steel frame build by using rectangular hollow pipes and steel rods these are connected by welding operation. The hylem boards are cut by using cutting operation. The dc wiper motor fitted on the frame by using bolt and nut joint. Power supply given from the dc battery (12volts and 7amps) through copper wires.

1. Linkages

A mechanical linkage is an assembly of bodies connected to manage forces and movement. The movement of a body, or link, is studied using geometry so the link is considered to be rigid. The connections between links are modeled as providing ideal movement, pure rotation or sliding for example, and are called joints.

A linkage modeled as a network of rigid links and ideal joints is called a kinematic chain. Linkages may be constructed from open chains, closed chains, or a combination of open and closed chains. Each link in a chain is connected by a joint to one or more other links. Thus, a kinematic chain can be modeled as a graph in which the links are paths and the joints are vertices, which is called a linkage graph.

The movement of an ideal joint is generally associated with a subgroup of the group of Euclidean displacements. The number of parameters in the subgroup is called the degrees of freedom (DOF) of the joint. Mechanical linkages are usually designed to transform a given input force and movement into a desired output force and movement.

The ratio of the output force to the input force is known as the mechanical of the linkage, while the ratio of the input speed to the output speed is known as the speed ratio. The speed ratio and mechanical advantage are defined so they yield the same number in an ideal linkage.

2. Dc motor

A DC motor is any of a class of electrical machines that converts direct current electrical power into mechanical power. The most common types rely on the forces produced by magnetic fields.

A windscreen wiper or windshield wiper is a device used to remove rain and debris from a windscreen or windshield. Almost all motor vehicles, including trains, watercraft and some aircraft, are equipped with such wipers, which are usually a legal requirement. A wiper generally consists of an arm, pivoting at one end and with a long rubber blade attached to the other.

The blade is swung back and forth over the glass, pushing water from its surface. The speed is normally adjustable, with several continuous speeds and often one or more "intermittent" settings. Most automobiles use two synchronized radial type arms, while many commercial vehicles use one or more pantograph arms.

Fig-13: DC Motor

3.DC battery

A battery is a device that can create electricity using a chemical reaction. It converts energy stored in molecules inside the battery into electricity. They produce direct current (DC) electricity (electricity that flows in one direction, and does not switch back and forth). Using the electricity from an outlet in a house or building is cheaper and uses less energy, but a battery can provide electricity in areas that do not have electric power distribution. It is also useful for things that moved around and cords would get in the way.

12V batteries are available for the use. And current will vary. Two wheelers have 7A and four wheelers have 40A. We use a 7a battery for this demonstration purpose.

Fig-14:DC Battery

4. Steel Frame

Steel frame is a building technique with a "skeleton frame" of vertical steel columns and horizontal I-beams, constructed in a rectangular grid to support the floors, roof and walls of a building which are all attached to the frame. The development of this technique made the construction of the skyscraper possible.

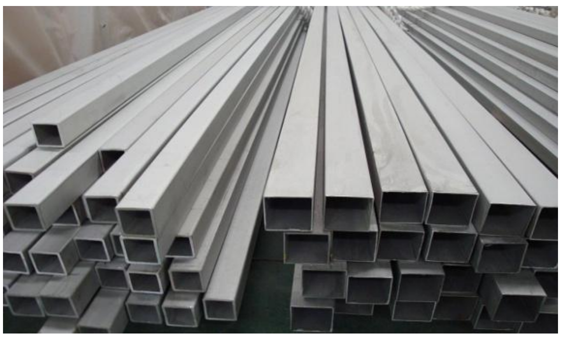

Fig-15: Steel Frame

3.2 Procedure

1. First of all we have prepared the drawing for the machine transporter machine.
2. Then we make the measurement for the bed of the box transport machine.
3. We took the iron angles and cut them in the given measurements using the cutting machine.
4. Then we took that pieces and weld them in the prepared shaped drawing.
5. After making the welding of the iron angles bed for the machine was ready.
6. Then we took the mild steel plate and then taking the measurement of box transport machine we cut the pieces in the given length.
7. After cutting the plate in the given size we put it in the lathe machine for giving it the shape of shaft as shown in the figure 10,11. We also prepared the hanger and crank using the lathe machine as per of dimension as shown in figure 12.
8. After preparing the shaft, hanger and crank we take it over the drill machine to make the holes in them as the given dimension in the drawing.
9. After this we had prepared the shaft which is going move the boxes to the next level with using it edges on the top of it. We cut the mild sheet plate in the given dimensions and then edges also, after cutting we make the welding to attach these edges with the plate on the given distance dimensions. Then with the help of file we rub these welding points to give them a good look.
10. Now all of the things for the machine are prepared.
11. On this step we took the electric motor and fix that on the bed of the machine on the given place.
12. After fixing the motor we fixed the crank with it from one side and other side was attached to the shaft 1 as shown in the fig 10.

13. Then we took the hanger link and attach it with the shaft 1, while the other edge of the hanger link is attached to the shaft 2, fig 11.
14. Then both of the shafts were attached to the transporting shaft as shown in fig 12.
15. Two other hanger links was also attached to the shafts.
16. Other two hanger link and transporting shaft was attached to the top of the bed in the bearing gear.
17. Out box transporting machine is ready now.
18. We give the current to the electric motor and put the boxes on the top of the machine for testing it.
19. It was working well and boxes are moving to the next level.

3.4 Working Principle

In this machine can comfortable for moving the product from one place to another place with safely. The machine is placed and working process is very easy for using persons. In this machine , the control unit is control the motor drive for rotation of the crank shaft .The motor is placed and the crank shaft is attached with the motor with the help of bearing. The products are safely placed in the stored place and then motor is ON , the crank is rotated and the first box is move from first place to second place in the first rotation , after that the second box is placed in the first position , the second rotation is started the first box is move from second place to third place , in the mean time the second box is move from first place to second place . In this based the boxes are move from one place to another place simultaneously .The products are safely transfer from one place to another in conveyor using crank mechanism.

Fig-16: Crank mechanism conveyor

3.4.1 Application

1. We can used this mechanism in medical production fields.
2. We can used this mechanism in bottle filling process.
3. We can used this mechanism in cool drinks production companies.

3.4.2 Advantages

1. Lubricants not required.
2. Simple to construct.
3. Low speed motor is sufficient
4. Easy maintenance.
5. Less skilled operator is sufficient.
6. Noise of operation is reduced

4 FUTURE SCOPE

Dynamic analysis is one of the very important phase in design the systems. A computer base modelling and simulation gives better understanding regarding rigid system parameters. There is much scope in development of an accurate mathematical model and subsequent simulations for the kinematic and dynamic analysis of the mechanical systems for the precise application in the industry.

5 CONCLUSION

The crank unit is defined in this paper, and the important role of the crank unit is discussed in the process of modular design and production of the Crank-group Driving Mechanism.A method achieving inertia force balancing of the Crank-group Driving Mechanism is proposed according to the special structure of the mechanism.Thefactors influencing mass moment of the balancing weights and its calculation method are elaborated. The study provides the theoretical basis for the modular design of the Crank-group Driving Mechanism.

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