International Journal of Latest Engineering Research and Applications (IJLERA) ISSN: 2455-7137

Volume – 02, Issue – 05, May – 2017, PP – 67-74

Trolley Turning and Lifting Mechanism

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Abstract: *The material handling vehicles usually take more time to adjust its position, and unload at the exact location. This paper explain the design and fabricate a trolley turning and lifting arrangement for such vehicles. This mechanism is proposed to make the unloading easier in multi direction,only by turning the trolley rather than the vehicle in order to make the work more economic and efficient.The reciprocating motion of piston is transmitted to the crankshaft, one end of which is connected to a magnet and stator coil arrangement which creates electrical power with crankshaft rotation by generating an electromagnetic field of 14.5V to 15.5V and store it into a 12 Volt battery. The battery power is used to run twomotors,one for the trolley rotation and another for the scissor jack. Initially the battery power is used to run first motor which is responsible for the trolley rotation. After rotating trolley to desire direction, the power supply is switched to the second motor to operate scissor jack for lifting of trolley and the material will be unloaded into the desired direction.*

Keywords: *Scissor jack,Series motor, Stator coil, Trolley, Worm gear.*

1. Introduction

The automotive sector is fast booming section in India. There are variable in automotive industry light and heavy motor vehicle. Heavy duty vehicle support as the backbone and confront to the working. A dumper whose material can easily be unloaded in one direction that is mostly to its rear end. These inefficiency is been overcomes by the multidirectional dumper.

Construction and civil works is one of the basic need of this availability of proper material handling equipment. The material supply to civil and construction is provided through trucks, dumper etc. The material should be properly loaded, managed, stacked, transported and unloaded. The trucks carries the material and transported to the required site and then unloads. The major issues arises over here, the incompatibility of the site with the fully loaded dumper which consumes more time.

Conventional Trolley in which the dumper unloads the material in only one direction. But this incapability can be fulfilled by a new method mechanism as the unidirectional dumper. This mechanism is an approach to reduce the idle time to settle the dumper. The material is unloaded in any direction and hence can be boldly stated as "Multidirectional Dumper." The major outcomes of multidirectional dumper has overcome space requirement which often result in road blocking. This paper suggests inversion in the existing mechanism providing the unloading in 1800 rotations. This mechanism prevents blocking of road, saves time and enhances productivity at lowest cost.

2. Literature Survey

Michael Kay [1], noted out the different ways of handling various materials. It involves "short-distance movement that usually takes place within the confines of a building such as a plant or a warehouse and between a building and a transportation agency". It can be used to create "time and place utility" through the handling, storage, and control of material, as distinct from manufacturing (i.e., fabrication and assembly operations), which creates "form utility" by changing the shape, form, and makeup of material. It is often said that material handling only adds to the cost of a product, it does not add to the value of a product. Although it does not provide a product with form utility, the time and place utility provided by it can add real value to a product.

Hemant and Nilesh [2], point out that trucks, tippers and dump trucks are used to transport loose material from one place to another place at construction site in mines or in dump yards to accomplish the actual site requirement. The existing system available is to unload material on back side. As considering the mines space available is very less due to which unloading material on left or right side is not possible to take this as a problem multisided tipper tilting is the need of time. To overcome one side tilting of trolley, multisided tilting mechanism is come into focus. This will help to reduce the efforts to unload loose material one side of tipper. Propose work is on placing three hydraulic cylinders each on front side, right side and left side of trolley to unload loose material on back side, left side and right side of trolley respectively. Some design modification is needed in existing system to work on multisided tipper tilting mechanism.

Praveen Raj et al. [3], pointed out that in the modern world though there are many developments in the field of engineering. Development of lift simplifies the effort of carrying heavy loads over stairs, it is not

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possible to use lift in all places like schools, college's constructional areas. This paper aims at developing a mechanism for easy transportation of heavy loads over stairs. The main objective is to find an efficient and user friendly method of carrying various objects through stairs using minimum effort from the user and to also provide a smooth movement while climbing the stair. A stair climber is manufactured with tri lobed wheel frames at both sides of the climber and three wheels on each sides are used in the tri lobed frame. The wheel assembly is rotated by a gear- motor mechanism where a direct current (DC) gear motor is used to provide the necessary power for rotation and a pinion- gear mesh is used for reducing the rotating speed of the wheel.

Abhimanyu, Deshmukh et al. [4], described that the three way tippers can unload materials in all three sides. Main hydraulic cylinder is placed at middle of front side of chassis i.e. one for back side tilting of the trolley and other two cylinders are placed on along lateral side of the chassis at appropriate distance for left and right side tilting of the trolley. Trolley is connected with chassis with the help of six hinges. Two hinges on each lateral side for left and right side tilting of trolley, two hinges on back side of chassis for back side tilting of trolley. Now with this mechanism it is possible to tilt trolley on all three sides i.e. back, left and right side. For backside unloading of material, hydraulic cylinder no. 1 is in operation and hinge must be disconnected manually by pulling pin from the hinge, for this hole. Diameter is provided on pin head to facilitate manual pulling by inserting rope inside the pin hole.

Kulkarni et al. [5], has clearly pointed that as per the survey more number of accidents happen due to more number of trolleys connected to a single tractor along with more load and it becomes difficult for the driver to control the tractor and its attachment trolleys. In this paper, they have designed a collapsible trolley that can be adjusted in size. So, to eliminate all the trolley related problems and reduce the cost, they have designed a simple trolley so that the work of two trolleys can be done in a single trolley. With this kind of design it becomes easy for the drivers to drive the tractor and the trolley to the long distance safely.

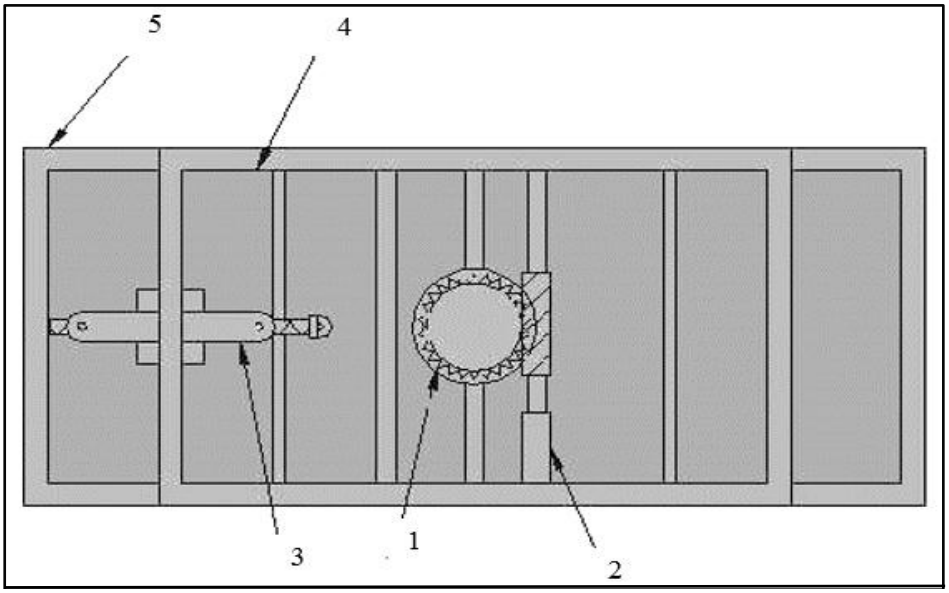
3.Design

To make a trolley turning to multi directions and unloading the material the two design considerations are;

- Trolley Turning Mechanism
- Trolley Lifting Mechanism

3.1 Trolley turning mechanism

The trolley turning mechanism is adopted to turn the trolley to the required position. This mechanism mainly consists of a movable frame, DC series motor. The basic arrangement of the turning mechanism is as shown in Fig.1 which consist of worm and worm gear, DC series motor, scissor jack, fixed frame, moving frame.



1. Worm and Worm Gear
2. DC Series Motor
3. Scissor Jack
4. Fixed Frame
5. Moving Frame

Fig.1 mechanism at the bottom

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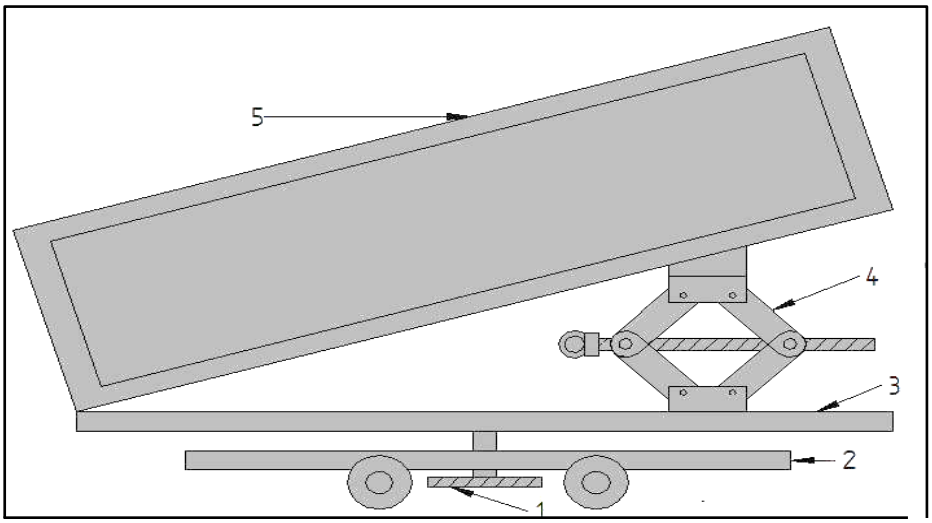
The trolley turning is achieved due to the rotation of the movable frame in which it is mounted. The movable frame revolves due to the rotation of the warm and warm gear arrangement by the use of the DC series motor.The motor is started by the use of the current stored into a 12 V battery.

3.2 Trolley lifting mechanism

The trolley lifting mechanism is adopted to lift the trolley to the required angle after turning it. This mechanism mainly consists of a movable frame and a scissor jack.The trolley lifting mechanism is shown in Fig. 2 below with components as of worm and worm gear, DC series motor, scissor jack, fixed frame, moving frame and trolley.



1. Worm and worm gear
2. Fixed frame
3. Moving frame
4. Scissor jack
5. Trolley

Fig. 2 trolley side view

The trolley lifting mechanism is achieved due to the operation of the scissor jack by the help of the DC series motor connected to it. The scissor jack is mounted on the movable frame. The motor is also started by the use of the current stored into a 12 V battery.The battery is continuously charging by the electrical power generated by the two stroke engine.

The fabrication of the trolley turning and lifting mechanism mainly consists of the following major components, they are:

- Trolley Body
- Fixed Frame
- Moving Frame
- Engine Frame

3.2.1 Trolley body

The trolley body is made of steel. The trolley body forms the part for carrying the materials. The trolley body is having a length, width and height of 914 mm, 660 mm and 254 mm respectively.

3.2.2 Fixed frame

The fixed frame forms the base of the trolley. This frame is made of Mild Steel (MS). It has four wheels attached to its two sides, the motor for running the gear arrangement for the rotation of the trolley.

3.2.3 Movable frame

The movable fame is made of Mild Steel, it is mounted above the DC series motor. This frame rotates along with the warm and warm wheel arrangement for the turning the trolley body which is mounted on it.

3.2.4 Engine frame

The engine frame is made of MS and it is having the dimensions of length, breadth and height of 450 mm, 300 mm and 450 mm respectively.

4. Design consideration

Design parameters considered for the model are;

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Calculation for Worm is given below
Load (W) =15×10^3 N

Speed of Worm (N_w) = 240 rpm
Speed of Gear (N_g) = 30 rpm
Velocity (V) = 0.6 m/s
Velocity Ratio: $VR = \frac{N_w}{N_g}$ (1)
$VR = \frac{240}{30}$
VR = 8
Efficiency of Worm: $\eta_w = (1 - 0.005) \times VR$ (2)
$\eta_w = (1 - 0.005) \times 8$
$\eta_w = 96\%$
Rated Power (P_R): $P_R = \frac{W \times V}{\eta_w}$ (3)
$P_R = \frac{15 \times 10^3 \times 0.6}{0.96}$
$P_R = 9375$ W
$P_R = 9.375$ KW
Calculation for Worm Gear is given below;
Normal pressure angle: $\emptyset_n = 14.5^o$
Outside diameter: $D_0 = D_g + 1.0315\ Pc$ (4)
$D_0 = 528 + 1.0315\ (\pi \times 11)$
$D_0 = 563.64$ mm
Throat diameter: $D_r = D_g + 1.0636\ Pc$ (5)
$D_r = 528 + 1.0636\ (\pi \times 11)$
$D_r = 564.75$ mm
Face width: $b = 2.38\ Pc + 6.25$ (6)
$b = 2.38\ (\pi \times 11) + 6.25$
b = 88.49 mm
Radius of gear face: $r = 0.882\ Pc + 13.75$ (7)
$r = 0.882\ (\pi \times 11) + 13.75$
r = 44.22 mm
Radius of gear rim: $r_b = 2.2\ Pc + 13.75$ (8)
$r_b = 2.2(\pi \times 11) + 13.75$
$r_b = 89.77$ mm
Radius of edge: $r_r = 0.25\ Pc$ (9)
$r_r = 0.25\ (\pi \times 11)$
$r_r = 8.63$ mm

5. Components selected and working process

The Trolley turning and lifting mechanism is the combination of many components which in turn produces the required final finished product.
The main components used are;

- DC Series Motor
- Scissor Jack
- Battery
- Two Stroke Engine
- Silencer

5.1 DC series motor

A direct current (DC) Series motor is an electric machine that converts electrical energy into a mechanical energy. In normal motoring mode, most electric motors operate through the interaction between an electric motor's magnetic field and winding currents to generate force within the motor. In certain applications, such as in the transportation industry with traction motors, electric motors can operate in both motoring and generating or braking modes to also produce electrical energy from mechanical energy. In applications DC Series motors are used in fans, blowers and pumps, machine tools, household appliances, power tools, and disk

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drives. DC motors can be powered by direct current (DC) sources, such as from batteries, motor vehicles or rectifiers, or by alternating current (AC) sources, such as from the power grid, inverters or generators. Small motors may be found in electric watches. General-purpose motors with highly standardized dimensions and characteristics provide convenient mechanical power for industrial use.

5.2 Scissor jack

A scissor jack is a type of jack that is operated by turning a lead scissor. In the form of a scissor jack it is commonly used to lift moderately heavy weights, such as vehicles. More commonly it is used as an adjustable support for heavy loads, such as the foundations of houses, or large vehicles.Scissor jacks over some other types of jack is that they are self-locking, which means when the rotational force on the scissor is removed, it will remain motionless where it was left and will not rotate backwards, regardless of how much load it is supporting. This makes them inherently safer than hydraulic jacks, for example, which will move backwards under load if the force on the hydraulic actuator is accidentally released.

5.3 Battery

An electric battery is a device consisting of one or more electrochemical cells with external connections provided to power the power DC Series device such as flashlights, smart phones, and electric cars. When a battery is supplying electric power, its positive terminal is the cathode and its negative terminal is the a mode. The terminal marked negative is the source of electrons that when connected to an external circuit will flow and deliver energy to an external device. When a battery is connected to an external circuit, electrolytes are able to move as ions within, allowing the chemical reactions to be completed at the separate terminals and so deliver energy to the external circuit. It is the movement of those ions within the battery which allows current to flow out of the battery to perform work. This battery uses lead acid, it is rechargeable and can store a power up to 12V.

5.4 Two stroke engine

A two-stroke engine is an internal combustion engine that completes the thermo dynamic in two movements of the piston compared to twice that number for a four-stroke engine. This increased efficiency is accomplished by using the beginning of the compression stroke and the end of the combustion stroke to perform simultaneously the intake and exhaust (orscavenging) functions. In this way two-stroke engines often provide strikingly high specific power. Gasoline (spark ignition) versions areparticularly useful in lightweight (portable) applications such as chainsaws and the concept is also used in diesel compression ignition engines in large and non-weight sensitive applications such as ships and locomotives.A fundamental difference from typical four-stroke engines is that the crankcase is sealed and forms part of the induction process in gasoline and hot bulb engines. Diesel engines have mostly a roots blower or piston pump for scavenging.There are no traditional valves in a two-stroke engine. In a two-stroke the engines fires once every revolution. This makes the engine highly efficient and lightweight compared to four-stroke systems. Rather than entering through valves, the fuel/air mixture enters through an intake port and exhaust exits out of an exhaust port. In place of traditional valves the two-stroke engine uses the piston's position to force out exhaust or suck in fuel mixture.

Specifications:

- Engine Type : 2 Stroke Air Cooled
- Displacement : 49.9 cc
- Compression Ratio : Compression
- Maximum Power : 2.61 Kw (3.5 BHP)
- Maximum Torque : 5 N-mm @ 3750 rpm
- Cylinder Bore : 46 mm
- Stroke : 42 mm
- Ignition : Fly wheel magneto 12V, 50W Electric ignition
-

5.5 Silencer

A silencer or muffler is a device for decreasing the amount of noise emitted by the exhaust of an internal combustion engine. They are installed within the exhaust system of most internal combustion engines, although the silencer is not designed to serve any primary exhaust function. The silencer is engineered as an acoustic soundproofing device designed to reduce the loudness of the sound pressure created by the engine by way of quieting. Majority of the sound pressure produced by the engine is emanated out of the vehicle using the same piping used by the silent exhaust gases absorbed by a series of passages and chambers lined with roving fiberglass insulation and/or resonating chambersharmonicallytuned to causedestructive

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interference wherein opposite sound waves cancel each other out. An unavoidable side effect of silencer use is an increase of back pressure which decreases engine efficiency. This is because the engine exhaust must share the same complex exit pathway built inside the silencer as the sound pressure that the silencer is designed to mitigate.

6. Working of the proposed model

The mechanical power from the engine is convert as electrical power and stored in the battery and utilized. The complete working process of this mechanism is discussed below.As the engine starts, the piston reciprocates inside the cylinder and this reciprocating motion is converted into a rotary motion of the crankshaft. At the left end of the crankshaft, a magnet is connected, which rotates along with the crankshaft. This magnet is surrounded by the electric coil.The magnet creates a magnetic field around it. These coils are placed around the magnet. When the magnetic flux is cut by the coils, it creates an electromagnetic field, and the potential of this field is 14.5V to 15.5V. The Fig. 3 shows the prototype of multi directional trolley purposed.

Fig. 3trolley prototype

The mechanical power produced from the engine is converted into the electrical power by the use of a magnet and the electric coils arrangement. This electric power is stored into a 12 V battery. The power from the batteryis used to run the two motors (one for the trolley rotation and another for the scissor jack).Initially the power from the battery goes to the trolley motor and runs it, which causes the turning action of the trolley. The direction of rotation of trolley can either be clockwise or counterclockwise which depends on the required direction of unloading the material.

The rotation of the trolley to different direction is achieved just by changing the polarity of connections to the battery. After turning the trolley and bringing it to the required position, the power supply is switched by the manual switches to the scissor jack motor to run it, which leads to the lifting action of the trolley. After getting the suitable inclination of trolley, the material can be unloaded to the particular location.

The trolley turning and lifting mechanism also capable of unloading the material in a particular angle The conventional dumpers need to adjust their position for unloading the materials at once in all the direction, in that situation this proposed mechanism is very useful because unloading in all direction at once can be achieved easily just by lifting the trolley and rotate it in order to dump the materials in multi directions. When unloading is over, the scissor jack motor is run again, which makes the trolley to come back to its horizontal position. When the power supply is switched to the trolley motor to bring it to the initial position.

The complete assembled view of trolley and engine is shown in Fig. 4 below.By this means the arrangement is capable of unloading material in all directions rather than the facing direction.

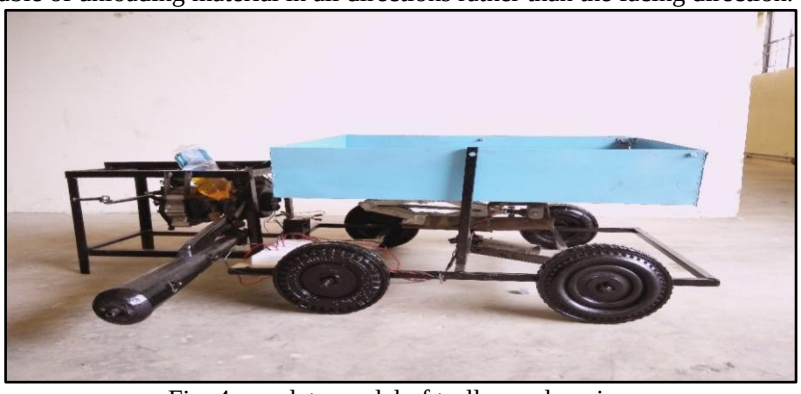

Fig. 4complete model of trolley and engine

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7. Performance analysis

The performance analysis of the trolley turning and lifting mechanism has clearly shown that the mechanism proposed is more efficient, economical and effective.The involvement of turning mechanism in dumper bring advantages like the material can be dumped in any direction with ease and the trolley can easily come back to its initial position.

Both turning and lifting mechanism of the trolley are getting power from the engine in the form of an electrical energy. This energy is first stored into a 12V battery and then supplied to the components. As the electrical power is used and transmitted to components by the use of electrical wires in place of any mechanical arrangement, this results in less noise, less wear of components and less vibration. Use of battery provides a smooth flow of current toward the components.

Sometimes it is not required to dump all the material in one direction, but also in the other two directions. In that case, a convention dumper after unloading materials in one direction, it needs to adjust its position for unloading in other two directions. But with the use of trolley turning mechanism this problem can be easily solve just by lifting the trolley and start turning it for the other directions.

In this model a scissor jack is used according to trolley capacity which is of 5 kg, when to carry more load, scissor jack can be replaced by the other powerful jack like hydraulic. As the complete mechanism is running with the engine power only, it doesn't require any other components. This will make the process as economic and efficient compared to the existing dumpers.

7.1 Tests performed

The various tests carried out for the performance analysis are vibration test, balancing test, turning test and lifting test.

- Vibration test
- Balancing test
- Turning test
- Lifting test

7.1.1 Vibration test

As the vehicle runs at higher speed it starts vibrating and this vibration effect transfers to the components also and if the excitation frequency of components meet with its natural frequency, it causes the catastrophic failure. In order to avoid that, the vibration test has to be performed and it is found satisfactorily performing within a comfortable range.

7.1.2 Balancing test

Balancing test is performed to check the balancing of when the trolley is in motion. As unbalancing leads to more vibration in the vehicle when the vehicle increases its speed.

7.1.3 Turning test

Turning test is performed to check the proper functioning of trolley's turning mechanism which involves a proper meshing of the worm with the worm wheel.

7.1.4 Lifting test

Lifting test involves the proper working of scissor jack which is operated by a DC series motor which causes the lift of trolley after bringing it to the unloading location.

These tests are conducted to ensure the proper working and improved performance of the unloading vehicles in an efficient and economical way.

As the above tests are conducted, the following advantages have been achieved, they are:

- Less vibration and noise.
- Less wear and tear of component due to less mechanical joints.
- Better control over trolley rotation.
- Better control over trolley lift.
- Easy way of arrangement.
- As the DC Series energy is used, this avoids friction and vibration problems.

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8. Conclusion

Nowadays trailers unload goods only in one direction which requires more time. This paper is proposing a trolley turning and lifting mechanism in order to make unloading easier. In the driver can unload the materials in multi direction without the consumption of extra time with a faster work rate and lesser human involvement.

Various tests are performed to analyze efficiency and results and evaluated based on speed and power. It is proved that the proposed mechanism is more effective than unloading mechanism commonly in use nowadays.

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