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## Design and fabrication of Three Axes Pneumatic Trailer for shipping Goods

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### Abstract

The objective of this paper is to evaluate the difficulty in unloading the materials. In this consideration, several automobiles garages have concede the facts that, some of the methods, which were most difficult, were endorsed in unloading the materials from the trailer. The loading and unloading of material using trailer is only in one single direction. Moreover, loading and unloading of material, in small compact streets and small roads, is done with high difficulty.

Now our project has mainly concentrated to rectify the loading and unloading of the trailer in all the three sides very easily with suitable arrangement of design. The loading of vehicle from the trailer can be done in three axes by activating the direction control valve, without the application of any impact forces. Compressed air is used in controlling the valve. The trailer cabin is lifted, by using the ram of the pneumatic cylinder as lifter. The compressor engine is coupled with automobile engine drive, so that, when vehicle is running, compressed air is stored. Pneumatic cylinder is activated by using the compressed air, when the valve is activated.

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### Keywords:

Trailers

Control Valve

Pneumatic Cylinder

Compressed air

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### 1. Introduction

In building sites, the vehicle used in carry materials is dumper. Dumpers are differentiated from dump trucks by structure: dump truck is having a cab in front of the load, while an open 4-wheeled vehicle with the load skip in front of the driver is a dumper. The name dumper has come from "The skip can tip to dump the load". They are usually powered with diesel. For the secondary use as a site tractor, a towing eye is fitted.

First the model is created using Pro-E Software and verified by applying kinematic motion for testing direction in which the damper is working. Later the components are fabricated and assembled manually. The fabrication of every part is described in systematic way.

## 2. Modelling

2.1 **Basic Idea of Modelling:** The following parts are be designed using Pro-E

Names of Parts To Be Designed: Chassis, Larger gear and assembly, smaller gear and motor assembly, Dumper.

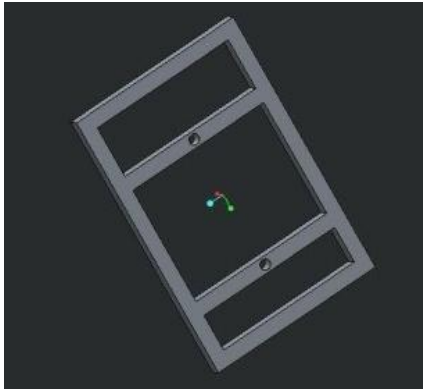


Fig 1: Chassis

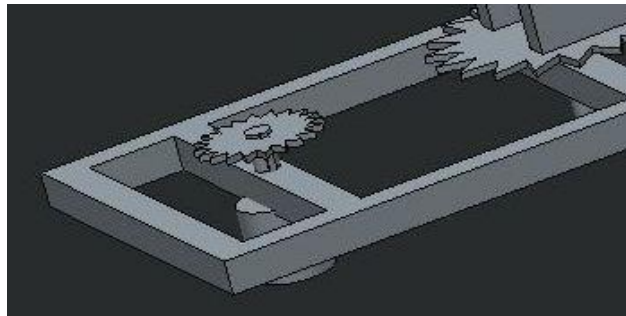


Fig 2: Extruded part of larger gear

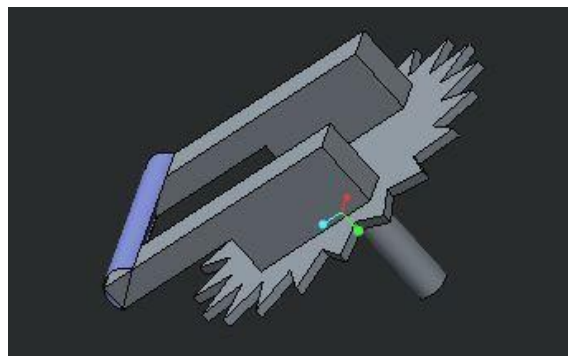


Fig 3: smaller gear wheel & Motor assembly

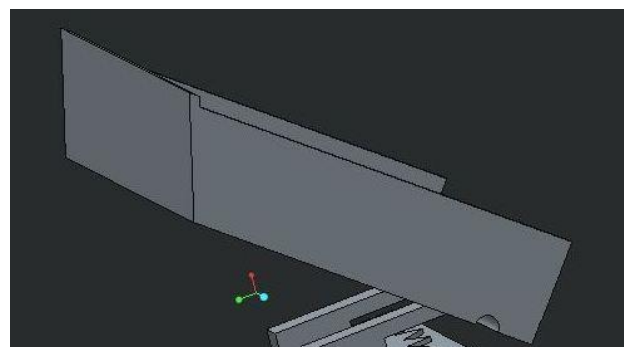
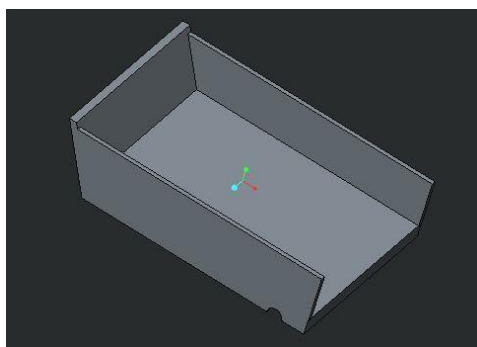


Fig 4: Different views of Dropping Dumper

## 2.2 Assembly of Designed Parts:

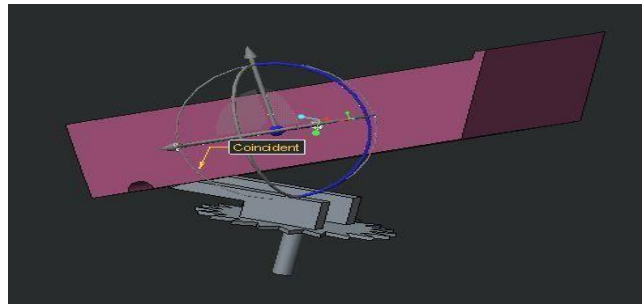


Fig 5: Assembly of the Design

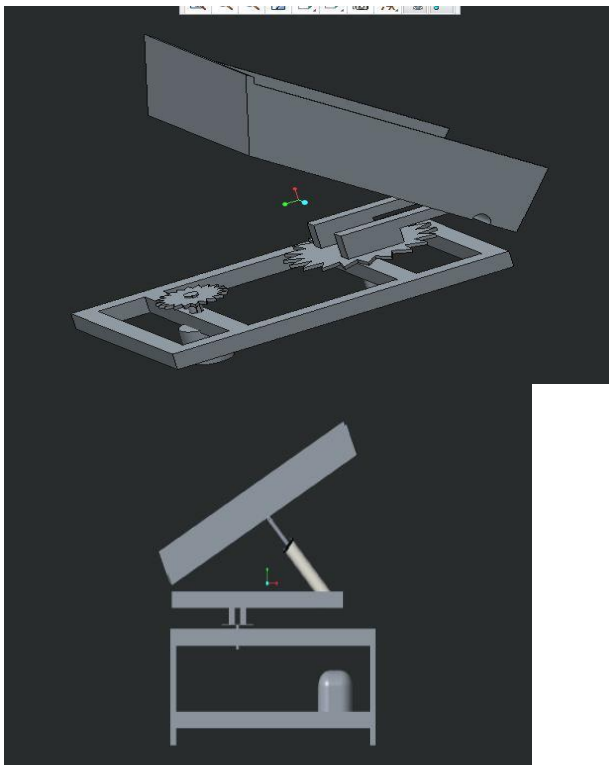


Fig 6: Total Assembly of the Unit

Fig 7: View of pneumatic trailer

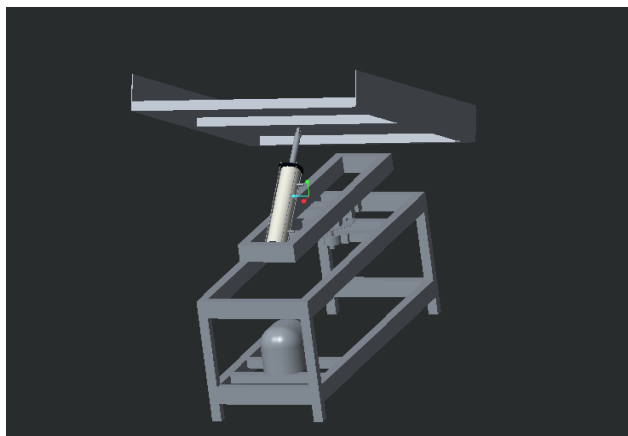


Fig 8: Isometric view of the mechanism

### 3. Components and Working Principle:

#### COMPONENTS:

The major parts pneumatic three axis modern tipper is described below:

- ☐ Air compressor
- ☐ Direction Control Valve
- ☐ Cylinder
- ☐ Connecting hoses
- ☐ Flow control valve
- ☐ Wheel arrangement
- ☐ Vehicle model frame
- ☐ Bearing assembled with bearing cap
- ☐ Rotating Plates

#### 3.1 Air Compressor:

The main function of the air compressor is to compress the air up to the required pressure. The maximum capacity of the compressor is 10105 to 12 105 N/m<sup>2</sup>. This is a two stages or two-cylinder reciprocating air compressor. The two cylinders are for low and high compression. The air pressure is measured at various places by the use of pressure gauges. V-belt and pulley are used to drive the compressor. Compressors are classified into two groups in general. They are:

- ☐ Positive Displacement Compressor
- ☐ Dynamic Compressor

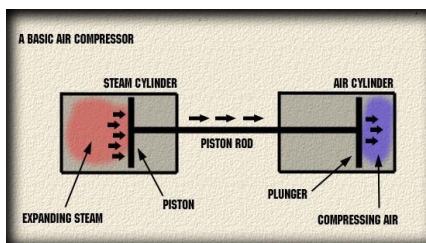


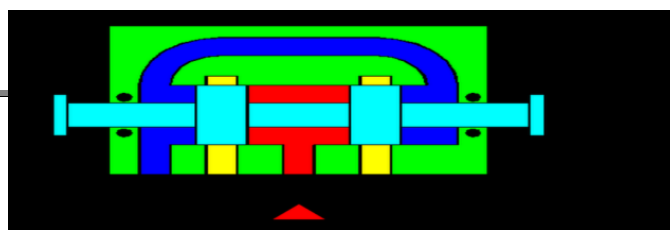
Fig 9: Air compressor

#### Positive Displacement Compressor:

Successive volumes of air isolated and then compressed to a higher pressure. There are essential two forms of positive displacement compressor, reciprocating and rotary.

#### 3.2 Direction Control Valve:

Directional control valves are one of the most fundamental parts in hydraulic machinery as well



and pneumatic machinery. One or more sources are used to allow fluid flow into different paths. Mechanically or electrically controlled spools are used inside the cylinder. The Controlling of fluid flow is generally restricted or permitted by movement of the spool.

Fig 10: Direction control valve

### Two way two position directional control valve:

Gate valve is case of 2W/2P directional control valve which either turns on or off the stream in ordinary or working position contingent upon need of utilization. Here indication of arrow shows that liquid stream is occurring while other position indicates cut-off position.

**Four way two position directional control valve:** 2 way position valves has four connections to it and two valve positions. One of them is normally open.

- **Pressure Gauge:**

Pressure gauge is used for measuring the outlet pressure of air from the compressor. Bourdon tube pressure gauge is used in gauge. The maximum capacity of this gauge is 10 105 to 12 105 N/m<sup>2</sup>. The gauge is fitted at the outlet of the air compressor.

- **Pneumatic valves:**

The pneumatic cylinder is regulated and controlled by pneumatic valves. These valves are actuated manually, mechanically, electrically, pneumatically, and by various combined mode of actuation. Types of single acting cylinders:

- ☐ Diaphragm cylinder
- ☐ Rolling diaphragm cylinder

### 3.3 Pneumatic Double acting cylinder:

To produce a force in a reciprocating linear motion, mechanical devices are used which use the power of compressed gas

An external agent is used to move the piston in the required direction, like hydraulic cylinders.

The force required to move the object is transferred from the piston rod and piston of the cylinder. Manufacturers and designers sometimes prefer to use pneumatics as they do not require large amounts of space for fluid storage and apart from that are quieter and cleaner. Moreover, leakage from a pneumatic cylinder will not drain out and spoil the surroundings. Operating fluid is gas and other conditions made pneumatics more desirable where eco friendly atmosphere is required.

**A double-acting cylinder:** Fluid at working condition is supplied alternately from both the sides of the piston in the cylinder. This mechanism is used in few hydraulic and pneumatic cylinders in common where force on both the sides are requires. It is used to retract the piston when force is not available externally as it requires high force in both directions of travel.



Fig 11: Pneumatic Cylinder

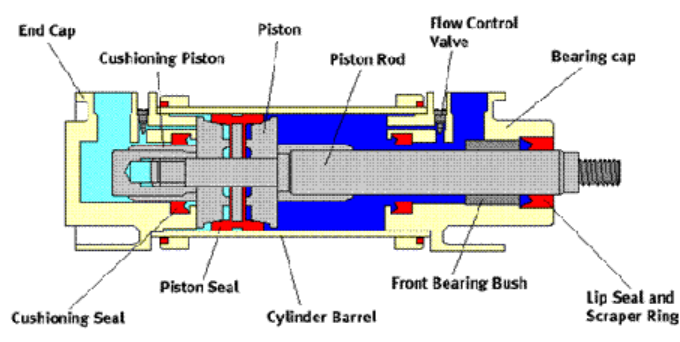


Fig 12: Schematic diagram of Pneumatic Double Acting Cylinder

**Air Seal:** Air pressure from the cylinder is prevented from the air leak using a seal which is normally made with the neoprene rubber. The efficiency of the cylinder decreases with the increase in leakage of the compressed air.

**Wiper Seal:** Dust materials are prohibited to enter into the cylinder by using Wiper Seal from the environment. Neoprene Rubber is used in this manufacturing.

**O Ring:** The perfect seal between the piston and the cylinder is maintained by fitting O Rings into the grooves of the piston. The material used for manufacturing is neoprene rubber. In some cases wire mesh also intruded.

**Cylinder Barrel:** It is made of cold drawn aluminum honed to 25mm.

**Piston Rod:** M.S. hard Chrome plated

**Seals:** Nitrile (Buna N) Elastomer

**End Covers:** Cast iron graded fine grained from 25mm to 300mm

**Piston:** The piston is made up of aluminum metal because of light weight and high durability.

**Media:** the media which is used for the modern hydraulic trailer system is usually Air.

**Temperature Range:** The temperature of the system usually ranges from 00c to 850c  
**Cushions:** Adjustable standard on 400mm bore and above

### 3.4 Flow Control Valve:

In any fluid power circuit, flow control valve is used to control the speed of the actuator. By varying the air passage through, flow control is achieved. Speed can be increased, by increasing area. The flow control can be achieved by varying the area of flow through which the air is passing. When area is increased, more quantity of air will be sent to actuator as a result its speed will increase.

A flow control valve regulates the flow or pressure of a fluid. Control valves normally respond to signals generated by independent devices such as flow meters or temperature gauges. Control valves are normally fitted with actuators and petitioners. Pneumatically-actuated globe valves and Diaphragm Valves are widely used for control purposes in many industries, although quarter-turn types such as (modified) ball, gate and butterfly valves are also used.



Fig 13: Flow Control Valve

### 3.5 Chain Drive:

Chain drives are used when large amounts of power are to be transferred in confined areas or precise control of speed ratios in the drive must be maintained. When kept in good repair, they are not subject to slippage and do not depend on friction to transfer the power.

A chain drive is made up of a chain and two wheels (sprockets) with teeth that fit into each link in the chain as the chain passes over the wheel. The chain links are made up of rollers that fit in the grooves between the teeth of the sprocket. These rollers are connected by side plates on each side that straddle each tooth on the sprocket as that chain passes over the sprocket. The distance from the center of one roller in the chain to the next is called the pitch length. Standard chain is referred to as roller chain and







Fig 14: Chain Drive

the size of the chain is expressed in the pitch length in 1/8-inch increments. This length is shown as the first number in the chain length size, a No. 60 chain has a pitch length of  $6 \times \frac{1}{8} = \frac{3}{4}$  inches. Roller chains sizes used in most chain drives vary from a No. 35 to a No. 240. Though chains normally come in single strands, double and triple strands are available to transmit greater power requirements through the drive.

#### 4 Working Principle:

In this modern three axis pneumatic trailer system, the air circuit plays a vital role in the system and it is necessary to understand the movement and working principle of the air circuit. First we can start with the compressing of the air; the atmospheric air which is normal pressure is taken by the reciprocating compressor and converted into higher pressure depending on the requirement. Cooling as to be provided for the compressed air to neutralized the heat generated by the compression process. The compressed air is supplied to the compressed air tank and the compressed air tank should have a drain to drain the water accumulated in the tank air moisture condensation. In the ship the main air bottle is used for the three axis trailer operation with the help of the pressure reducing valve because the main air bottle pressure is nearly stored at 35 bars for the main engine starting operation. In the modern three axis pneumatic trailer system we need maximum of 7 bars, 35 bars air pressure will damage the system. But some cases the variable pressure reducing valve will be used depending the requirement of the system also direction control valve are available for the desired operation.

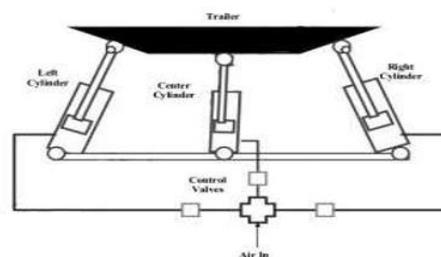


Fig 15: Circuit diagram of three Axis Pneumatic Modern Trailer

For the pneumatic circuits usually the 5/2 direction control valve is used for the better compatibility. The figure shows the circuit diagram of the modern three axis pneumatic modern trailer. The air which is compressed in the compressor is sent to the 5/2 direction control valve. The 5/2 direction control valve will change the flow direction of the compressed air depending on the handle valve position. Then the compressed air from the direction control valve is sent to the cylinder block depending on the valve position. The compressed air admitted in the cylinder block will push the piston upwards. The piston stroke length can be adjusted by means of the operation of handle lever valve position. The lifting of the trailer will be done by three cylinder block attached with the trailer as shown in the figure.



Fig 16: Fabricated model

**Methodology:**

By using single cylinder, we try to achieve the desired power. The axis of the cylinder is been rotated by mounting cylinder on rotating plate.

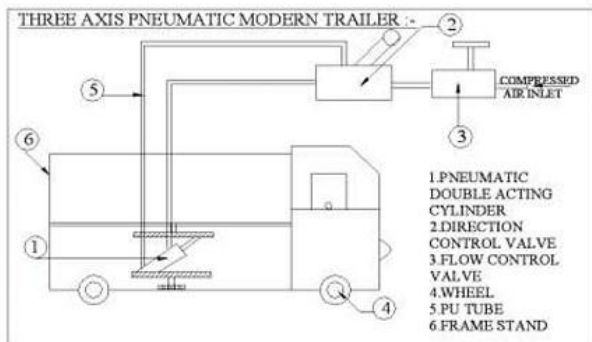


Fig 17: Methodology

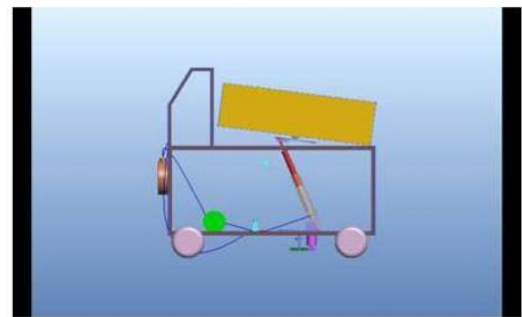


Fig 18: Back Dumping



Fig 19: Fabricated Final Model





Fig20: Fabricated model of Three Axis Pneumatic Dumper

### Conclusion:

This paper will review the need of the modern three axis pneumatic trailer for the ship to perform the operation of lifting heavy weight materials. This paper also studies the importance of pneumatic circuit system and its application in shipping industry. Various parts of the modern three axis pneumatic trailers were studied and their performance was analyzed in terms of the work. Further review is made on the practical plastic model of project with analysis of working and with the help of pneumatic system lifting operations can be easily carried out without much effort and without outsourcing. This mechanism cannot only applicable in the shipping industry but also it is applicable for various manufacturing industries.

Thus, three axis pneumatic trailers for shipping goods are manufactured. This is to achieve low cost automation with simple mechanics. The trailer can be operated by the persons with minimum technical knowledge. The model obtained is portable to carry fewer weights which can be extended to heavy loads by improving capacity of the Cylinder.

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