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ABSTRACT

Our primary endeavour is a modern three-axis pneumatic trailer that employs microcontrollers and pneumatic mechanism principles. The effectiveness of dumping trailers will improve as a result of this effort. Materials can be unloaded in one of three directions. The maritime sector will find this quite helpful. We chose this project in order to save time and manpower. Our project demonstrates the use of microcontrollers and pneumatics. The numerous benefits of pneumatics are why we chose this project.

Keywords: Pneumatic cylinder, valves, compressor, modern caravan.

1. INTRODUCTION

Automation in today's world is critical to the growth of manufacturing sectors. Depending on the requirements, manufacturing sectors can be automated using hydraulic systems, pneumatic systems, and robotic systems coupled with computers. Out of these systems, the pneumatic system plays an important part in automation and serves as an appealing medium. In this study, we will look at automation in the shipping industry. Automation in the shipping industry was used for the following reasons:

- To minimise manpower
- To improve ship manoeuvrability
- To increase seaman rest time
- To extend the life of machinery
- To assume greater responsibility
- To achieve greater safety
- To obtain greater controllability
- To reduce maintenance costs.

"Pneuma" is a Greek term that means "breathing wind." Pneumatics is a discipline of science that deals with the study of air movement and characterization. However, pneumatics is commonly understood as the use of air in the manufacturing and shipping industries as a working medium for regulating and operating machines and equipment. Originally, pneumatic systems were used to accomplish basic mechanical duties aboard ships, but in recent years, pneumatics has played an important role in the development of automation technologies. Compressed air is employed as a working medium in the pneumatic system. Depending on the needs of the pneumatic system, a sufficient quantity of compressed air at the requisite pressure should be made available. There are different types of compressors available in the world, with the reciprocating compressor being the most suitable for all applications. There are various sizes of

reciprocating compressors available, ranging from small portables to very large ones. The compressor will fill the proper-sized air bottle[1].

A single-stage reciprocating air compressor will output air pressures ranging from 6 to 15 bars. Additional stages of high-pressure reciprocating compressors can be used to provide a maximum discharge capacity of 250 bars. The compressors should have all of the appropriate safety mountings for a safe atmosphere. In the case of a ship, a high-capacity reciprocating air compressor is already present for starting the main engine, which can also be used for the automation system. This can lower the cost of installing automation[2].

2. CURRENT METHODOLOGY

The earliest dump truck, which was used to move and dump material, was nothing more than a simple dump body-style cart carried by horses. It would have been a two-wheeled cart hinged to the axle, with the centre of gravity exactly behind the axle when laden. The loaded front body was hooked and would dump if unlatched. These carts were employed in open mines and were pulled along a railway track by horses. A four-wheeled horse-drawn flatbed waggon with a rectangular body hoisted with a hand hoist in the front was used after 1900.

3. MODERN PNEUMATIC THREE-AXIS TRAILER

The pneumatic three-axis modern trailer is nothing more than one of the emergency lifting systems in automobiles. This lifting method is pneumatically controlled. In this case, the additional pneumatic cylinder and control valve are built within the vehicle itself. The control valve is used in this project to activate and deactivate the air input. When the valve is turned "on," compressed air is directed to the pneumatic cylinder. The compressed air then goes through the tube and pushes the pneumatic cylinder, causing the lifting to be applied when the valve is in the "ON" position (i.e., emergency time). The flow control valve is used to change the speed of the pneumatic cylinder. This is how the trailer's lifting speed is controlled in an emergency. This pneumatic modern trailer mechanism must be used in load-lifting vehicles in our project. The control valve is located near the driving position of the four-wheeler. The compressed air is already in the air tank. When the valve was turned on during an emergency, the control valve was triggered. The valve is known as a "flow control valve" because it controls the compressed air flow. This air flow is already established. The pressurised air is then routed to the pneumatic cylinders. When compressed air is introduced into the cylinder, the piston of the pneumatic cylinder advances. The pneumatic cylinder advances towards the lifting configuration[3].



Fig.: Pneumatic Triple Axis E-JCB MODEL

➤ **Advantages:-**

- The cost of lifting will be lower.
- No wear adjustment is required.
- Lower energy consumption
- Technicians with fewer skills are sufficient to operate.
- Installation is greatly simplified.

4. WORKING PRINCIPLE

The air circuit is critical in this current three-axis pneumatic trailer system, and it is crucial to grasp the movement and functioning concept of the air circuit. To begin, we can compress the air; normal atmospheric air is taken by the reciprocating compressor and changed into greater pressure based on necessity. The compressed air must be cooled to offset the heat generated by the compression process. The compressed air is delivered to the compressed air tank, which should include a drain to drain the water that has accumulated due to tank air moisture condensation. Because the main air bottle pressure is practically stored at 35 bars for the main engine starting operation, the main air bottle is used for three-axis trailer operation in the ship with the use of a pressure reduction valve. A maximum of 7 bars of air pressure is required in a modern three-axis pneumatic trailer system; 35 bars of air pressure will harm the system. However, depending on the system requirements, a variable pressure lowering valve may be employed in some circumstances. A direction control valve is also available for the desired function[4].

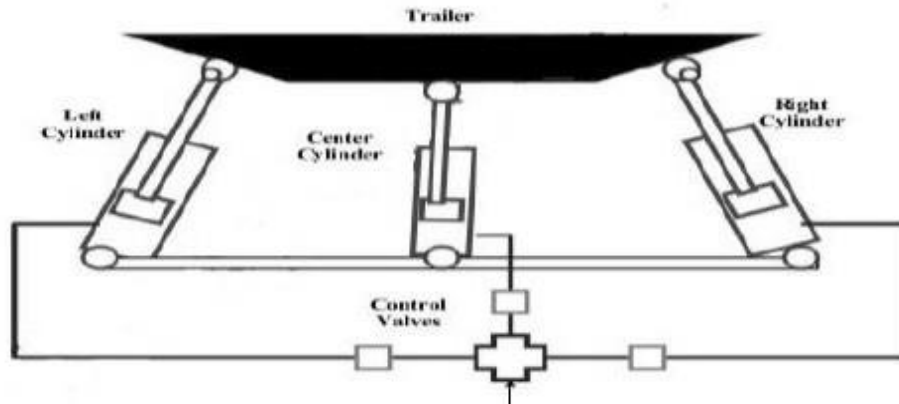


Fig.: Three-axis pneumatic modern caravan circuit schematic

For improved compatibility, the 5/2 direction control valve is typically used in pneumatic circuits. The diagram depicts the circuit diagram of a modern three-axis pneumatic trailer. The compressed air from the compressor is routed to the 5/2 direction control valve. Depending on the position of the handle valve, the 5/2 direction control valve will change the flow direction of the compressed air. The compressed air from the direction control valve is then routed to the cylinder block based on the position of the valve. The piston will be pushed upward by the compressed air supplied into the cylinder block. The piston stroke length can be varied by adjusting the hand lever valve position. The trailer will be lifted by three cylinder blocks attached to the trailer, as depicted in the image[5].

5. MAJOR COMPONENTS & DESCRIPTION

The following are the key components of a pneumatic three-axis contemporary tipper:

- Air compressor
 - Direction Control Valve
 - Flow Control Valve
 - Pressure Control Valve
 - Single Acting Cylinder
 - Electric Brushless DC Motor
 - Differential
 - Battery
 - Air Seal
 - Wiper Seal
 - O Ring
 - Cylinder Barrel
 - Piston
 - Connecting Hoses
- **Air Compressor:** The working of the air compressor is same as the two-stroke engine. It consists of a piston, inlet-outlet valves, cylinder with an adequate cooling arrangement, connecting rod and crank. The pistons are fitted with piston rings to avoid gas leakage. Both valves are designed to quick and leak-free operation.
 - **Direction Control Valve:** Fluids or gases can flow into diverse channels from valve ports, which provide a passageway for flow to or from other components or sources.

- **Flow Control Valve:** They are used to control the flow of compressed air. The speed of the pneumatic cylinder can be directly controlled by adjusting the flow rate.
- **Pressure Control Valve:** They assist in a variety of duties, including keeping system pressures below a predetermined limit or maintaining a predetermined pressure level in a portion of a circuit.
- **Single Acting Cylinder:** A single-acting cylinder is a type of pneumatic cylinder used in an electric JCB that generates force only in one direction. It is typically used in situations where the cylinder's force is only required in one direction, such as lifting or pushing. A single-acting cylinder is made up of a piston, a cylinder body, and a port via which compressed air enters and exits the cylinder. When compressed air is introduced into the cylinder, it forces the piston in one direction. When the pressurised air is released, the piston is returned to its original position by a spring or gravity.
- **Electric Brushless DC Motor:** The BLDC motor operates on the basis that a current-carrying conductor receives a force whenever it is placed in a magnetic field. The magnet will feel an equal and opposite force as a result of the reaction force. It has more torque, more efficiency, simple speed control, less noise, and a longer life span.
- **Differential:** The differential is a gear system that allows various drive wheels (the wheels to which engine power is transferred) on the same axle to revolve at different speeds, such as when the car is turning.
- **Battery:** A battery is a type of energy accumulator that stores electricity for use in an alternating or continuous-current engine. The battery is what makes these cars sustainable and frees them from their reliance on fossil fuels.
- **Air Seal:** An air seal is used to prevent air pressure loss from the cylinder. It is often constructed of neoprene rubber. The efficiency of the system will be reduced if there are any air leaks.
- **Wiper Seal:** A wiper seal is supplied at the cylinder's opening to prevent dusty items from entering. It is constructed of neoprene rubber.
- **O Ring:** O rings are inserted into the piston grooves to maintain a perfect seal between the piston and the cylinder wall. They are primarily constructed of neoprene rubber. Wire mesh was also used in some circumstances.
- **Cylinder Barrel:** The cylinder barrel is composed of cold-drawn aluminium that has been honed to a diameter of 25mm.
- **Piston:** Because of its light weight and great durability, the piston is made of aluminium alloy.
- **Connecting Hoses:** Hoses and tubes are commonly used in pneumatic systems to transmit compressed air from the main air supply line to additional components or sources via flexible tubing or hoses. Polyethylene hoses are used because they are chemically resistant, abrasion-resistant, temperature-resistant, flexible, and light in weight.

6. FUTURE SCOPE

Looking ahead, the pneumatic triple-axis electric JCB provides a wide range of possible uses and development opportunities. One potential growth area is the construction of environmentally friendly and sustainable structures, where the JCB's electric power and pneumatic systems can help reduce carbon emissions and improve energy efficiency. Furthermore, the increased manoeuvrability and flexibility of the JCB make it well-suited for usage on

increasingly complicated and urbanised building sites. As technology advances, possibilities to further optimise and polish the JCB's design and functionality may arise, making it an even more important tool for the future construction industry.

7. CONCLUSION

This study will examine the requirement for a modern three-axis pneumatic trailer for a ship to perform the function of lifting heavy materials. This article also investigates the significance of pneumatic circuit systems and their application in the shipping sector. Various components of a modern three-axis pneumatic trailer were researched, and their performance in terms of work was evaluated. Further cost-benefit analysis with different lifting systems is performed, and with the help of the pneumatic system, lifting operations may be readily carried out without much effort or outsourcing. This method is relevant not just to the transportation business but also to a variety of manufacturing enterprises. As a result, we created a "three-axis pneumatic modern tipper" to demonstrate how to achieve low-cost automation. This system's working process is so easy that anyone can use it. They can be adjusted and developed based on the applications by employing additional strategies.

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