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Design and Performance Analysis of a Pneumatically Operated Vice and Jack System

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Abstract - This project deals with the design and development of a pneumatic vice and jack system to reduce human effort and increase working efficiency in industrial and automobile applications. In many workshops, clamping and lifting operations are still done manually, which requires more time and physical strength. To overcome this problem, a pneumatic system is used that works with compressed air to operate the vice and jack automatically. The pneumatic vice is used to hold the work piece firmly during machining or assembly operations, while the pneumatic jack is used to lift vehicles or heavy loads. The system mainly consists of a compressor, pneumatic cylinder, control valves, and connecting pipes. When compressed air is supplied, the cylinder moves and performs the clamping or lifting action smoothly and quickly.

***Key Words*:** Pneumatic Vice and Jack.

1. INTRODUCTION

In today's industries and automobile workshops, holding and lifting heavy objects is a very common task. Traditionally, vices and jacks are operated manually using hand force. This method is slow, requires more physical effort, and can cause fatigue or even injury to the worker. With the growth of automation, there is a need to develop systems that reduce human effort and increase efficiency.

Pneumatics is a branch of engineering that uses compressed air to do mechanical work. Pneumatic systems are widely used because they are clean, safe, simple in design, and easy to maintain. By using pneumatics, machines can be operated faster and with less effort.

2. LITERATURE REVIEW

- Many researchers and engineers have studied and developed different types of vices and jacks to reduce manual work and increase efficiency in industries. Earlier, most of the vices and jacks were operated by hand. These required more physical effort and time, which reduced productivity and caused fatigue to workers.
- Some studies have shown that pneumatic systems are very useful in workshop applications because they use compressed air, which is clean, safe, and easy to control. Researchers have designed pneumatic vices that can hold workpieces automatically using air pressure. These systems provide uniform clamping force and reduce the chances of damage to the workpiece Simplified production
- Lower component count
- Enhanced safety during lifting.

Therefore, a simplified design for the motorized system with adaptive control is recommended.

3. PROBLEM STATEMENT

Manual vices and jacks need effort that is more human.
Clamping and lifting take more time.
Workers get tired easily.
Risk of accidents is more.
Productivity is low.
Heavy loads are hard to lift manually.
Need a faster and safer system.
Need to reduce manual labor.
Need easy operation.
Pneumatic system is the solution.

4. PROPOSED METHODOLOGY

First, study the working of manual vice, jack, and understand their problems. Learn basic details about pneumatic systems and their components. Design the layout of the pneumatic vice and jack system.

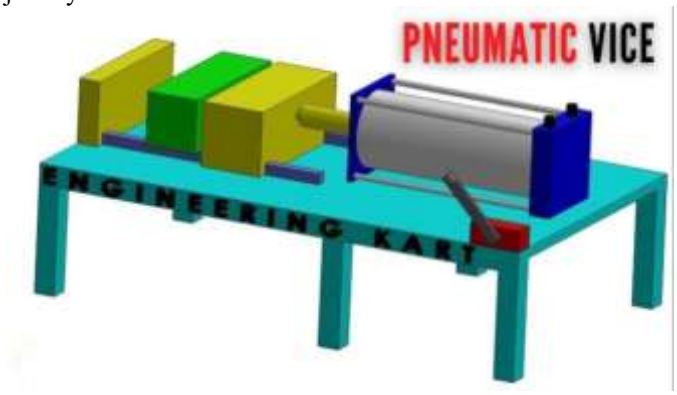

Fig -1: Pneumatic Vice

5. PNEUMATIC COMPONENTS AND ITS SPECIFICATION

The pneumatic jack machine consists of the following components to fulfill the requirements of complete operation of the machine.

Double acting pneumatic cylinder
Solenoid valve
Flow control valve
Connectors
Hoses

1.1. Double acting pneumatic cylinder:
Piston rod : 10 mm = 10×10^{-3} m
Quantity : 1
Seals : Nitrile (Buna-N) Elastomer

End cones : Cast iron
Piston : EN-8
Media : Air
Temperature : 0–80°C
Pressure Range : 8 N/m²

1.2. Solenoid Valve
Technical data
Size : 0.635 × 10^{-2} m
Part size : G0.635 × 10^{-2} m
Maximum pressure range : 0–10 × 10^{5} N/m²
Quantity : 1

1.3. Flow control valve: Technical data
Port size : 0.635 × 10^{-2} m
Pressure : 0.8 × 10^{5} N/m²
Media : Air
Quantity : 1

1.4. Connectors
Technical data
Max working pressure: 10 × 10^{5} N/m²
Temperature : 0–100°C
Fluid media : Air
Material : Brass

1.5. Hoses
Technical data
Max pressure : 10 × 10^{5} N/m²
Outer diameter : 6 mm = 6 × 10^{-3} m
Inner diameter : 3.5 mm = 3.5 × 10^{-3} m
Pneumatic unit
Type of cylinder : Double acting cylinder
Type of valve : Flow control valve & solenoid valve
Max air pressure : 8 × 10^{5} N/m²

1.6. DESIGN CALCULATION
Max pressure applied in the cylinder (p)
: 8 × 10^{5} N/m²
Area of cylinder (A)
= (3.14 / 4) × D²
= 80.38 mm²
= 80.38 × 10^{-6} m²
Force exerted in the piston (F)
= Pressure applied × area of cylinder

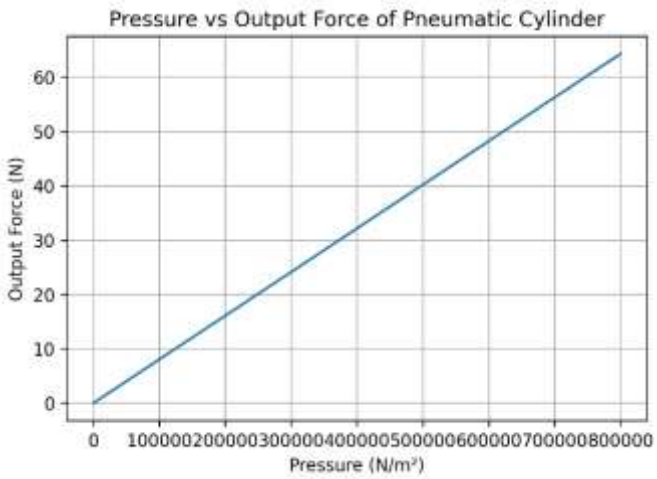

Chart **-1:** Pressure vs Output Force Characteristics of a Double Acting Pneumatic Cylinder

7. CONCLUSIONS

The pneumatic vice and jack system is very useful for reducing human effort and saving time in workshop operations. It makes clamping and lifting work easy, fast, and safe. By using compressed air, the system works smoothly and does not need much physical strength. This helps workers feel less tired and improves productivity.

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