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Design and Fabrication of Staircase Climbing Trolley

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ABSTRACT

Transporting heavy loads on staircases is a difficult and physically demanding task in many environments such as warehouses, residential buildings, hospitals, and construction sites. Conventional trolleys are suitable only for flat surfaces and cannot move efficiently on staircases. This paper presents the design and fabrication of a staircase climbing trolley which can easily move loads up and down stairs with minimum human effort. The trolley uses a tri-wheel mechanism that allows continuous rotation and smooth climbing over stair edges. The design focuses on strength, stability, portability, and ease of operation. The materials and components used in the fabrication include mild steel frame, rotating wheel assembly, axle, and handle structure. The fabricated model was tested on different staircase conditions to evaluate performance. The results show that the trolley can transport loads safely and efficiently over staircases with reduced human effort. This system can be useful in industries, hospitals, residential buildings, and delivery services.

Key Words: Staircase climbing trolley, tri-wheel mechanism, material handling, mechanical design, load transportation.

1. INTRODUCTION

Material handling is an important part of industrial and domestic activities. Moving heavy objects between floors using stairs is a challenging task and may cause physical strain or injury to workers. Conventional trolleys or carts are designed for smooth surfaces and cannot operate efficiently on stairs.

To solve this problem, a **staircase climbing trolley** is designed which can move loads up and down stairs easily. The system uses a special wheel arrangement that allows the trolley to climb stairs without lifting the entire load manually.

The main objectives of this project are:

- To design a trolley capable of climbing stairs.
- To reduce human effort required for transporting loads.
- To ensure safety and stability during movement.
- To fabricate a cost-effective and simple mechanical system.

This project mainly focuses on improving efficiency in manual material handling systems.

2.LITERATURE REVIEW

Several researchers have worked on mechanisms that assist in stair climbing transportation systems. Different mechanisms such as **tri-star wheels, caterpillar tracks, and motorized climbing systems** have been studied.

Tri-wheel mechanisms are widely used due to their simplicity and reliability. They consist of three wheels arranged in a triangular structure that rotates when the trolley encounters a stair edge.

Previous studies show that staircase climbing trolleys significantly reduce physical strain and increase transportation efficiency in multi-storey environments.

3.PROBLEM STATEMENT

Transporting heavy loads on staircases is difficult and unsafe when using conventional trolleys. Workers often need to lift loads manually, which can cause fatigue, injuries, and accidents. Therefore, a mechanical system is required that can easily move loads on stairs with minimum effort.

4.OBJECTIVES

The main objectives of this project are:

1. To design a simple and efficient staircase climbing trolley.
2. To develop a mechanism capable of climbing stairs smoothly.
3. To reduce human effort and increase safety.
4. To fabricate a durable and low-cost prototype.

5.DESIGN OF STAIRCASE CLIMBING TROLLEY

The staircase climbing trolley consists of the following major components:

5.1 Frame

The frame provides structural support to the entire trolley. It is made from mild steel square pipes for strength and durability.

5.2 Tri-Wheel Mechanism

The tri-wheel mechanism is the key component of the trolley. It consists of three wheels mounted on a rotating plate arranged in triangular form. When the trolley reaches a stair edge, the wheel assembly rotates and allows the trolley to climb to the next step.

5.3 Wheels

Rubber coated wheels are used to provide better grip and smooth motion during climbing.

5.4 Handle

The handle allows the user to pull or push the trolley comfortably. It is designed ergonomically for easy operation.

5.5 Axle

The axle connects the wheels and allows rotational movement of the tri-wheel mechanism**.**

6.WORKING PRINCIPLE

The staircase climbing trolley works on the principle of rotational motion of a tri-wheel assembly.

When the trolley reaches the first stair edge, the lower wheel touches the step.

As force is applied to pull the trolley, the tri-wheel mechanism rotates.

The next wheel comes in contact with the upper step.

This process continues until the trolley reaches the top of the staircase.

This mechanism allows the trolley to move smoothly from one step to another without lifting the load manually.

7.ADVANTAGES

Reduces human effort in carrying heavy loads.

Simple mechanical design.

Low manufacturing cost.

Easy to operate.

Suitable for residential and industrial use.

8.APPLICATIONS

Warehouses

Delivery services

Hospitals

Residential buildings

Construction sites

9.RESULTS AND DISCUSSION

The fabricated staircase climbing trolley was tested on standard staircases. The trolley successfully transported loads of approximately 40–60 kg without difficulty. The tri-wheel mechanism enabled smooth climbing with minimum effort. The system proved to be stable and reliable during operation.

10.CONCLUSION

The staircase climbing trolley is an effective solution for transporting loads on staircases. The design uses a simple tri-wheel mechanism which allows smooth movement across steps. The fabricated prototype successfully demonstrated the ability to carry heavy loads with reduced human effort. This system can be widely used in residential buildings, warehouses, and delivery services to improve efficiency and safety in material handling.

Future improvements may include motorized climbing mechanisms, lightweight materials, and improved ergonomic design.

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