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Design and Fabrication of Manual Tyre Changer for Cars

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Abstract

This paper presents the design and fabrication of a cost-effective manual tyre changer for cars, addressing the challenges of tyre removal and installation without relying on expensive automated machines. The proposed system includes a bead breaker, a mounting/demounting arm, and a stable clamping system to facilitate efficient operation. The study explores material selection, structural design, and ergonomic considerations. Testing and evaluation confirm that the fabricated system enhances ease of use, reduces operational effort, and is suitable for small workshops and individual users.

Keywords: Manual tyre changer, bead breaker, tyre mounting, fabrication, ergonomic design.

1. Introduction:

The manual operated tyre changer machine is an essential tool in automotive service, designed to removal and installation of tyres of various vehicles.Unlike electric or automated tyre changers, this device depends on human effort, making it an ideal choice for smaller workshops, Auto-mobile repair service stations. The project aims to address the growing need for cost-effective and efficient tyre changing solutions that can be operated without electricity, hydraulics power or compressed air.

1.1 Problem Statement

Traditional tyre-changing methods are labor-intensive, time-consuming, and often cause rim or tyre damage, while automated machines are expensive and inaccessible for small workshops and individual users. There is a need for a cost-effective, durable, and user-friendly manual tyre changer that simplifies tyre removal and installation while reducing effort and improving efficiency.

1.2 Objectives

The primary objectives of this project are as follows:

1. To design and develop a manual tyre changer that is straightforward to operate and ergonomically for users.
2. To analyze the mechanical principles and forces involved in the process of changing tyres to ensure maximum efficiency and safety.
3. To evaluate the cost-effectiveness of the manual operation in contrast to automated machinery.

2. Literature Review

Several tyre-changing mechanisms exist, including fully automated, semi-automatic, and manual changers. Automated machines offer high efficiency but are expensive, whereas existing manual changers lack ergonomic design. Research studies highlight the need for an improved low-cost manual tyre changer with enhanced usability.

Anderson et al. (2018) conducted a study comparing traditional manual methods, such as pry bars and hammers, with commercially available manual tyre changers. Their findings highlighted that traditional tools require excessive force and often cause rim damage, whereas improved manual changers with mechanical leverage systems reduce effort but still have design inefficiencies.

Kumar and Patel (2021) evaluated commercially available manual tyre changers and identified key drawbacks, including unstable clamping mechanisms, inefficient bead-breaking systems, and user fatigue due to poor ergonomic design. They suggested that integrating a lever-assisted bead breaker and a more stable base could enhance usability.

Smith et al. (2019), worked on automated tyre changers which significantly improved the efficiency of tyre removal and installation in professional settings. According to his study, automated systems incorporate hydraulic and pneumatic mechanisms to break the bead and mount/demount tyres with minimal manual effort. These machines ensure precision, reduce the risk of tyre and rim damage, and are widely used in commercial garages.

Johnson and Wang (2020) analyzed different automated tyre-changing technologies and found that while they improve efficiency, their high initial cost, space requirements, and maintenance demands make them unsuitable for small workshops and individual users.

3. Design and Methodology

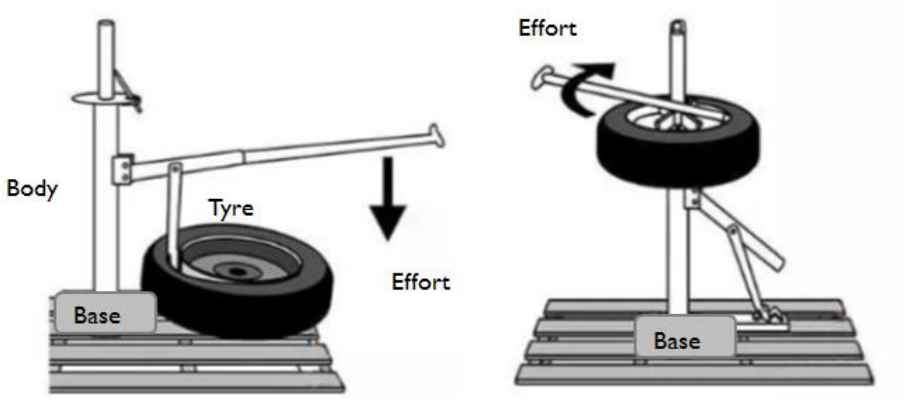
3.1. Design Considerations

The design of the manual tyre changer focuses on efficiency, durability, and user-friendliness. Key considerations include:

- **Material Selection**: Mild steel is chosen for its strength, durability, and affordability.
- **Bead Breaker Mechanism**: A long-lever system with a fulcrum point near the tyre ensures easier bead separation with minimal effort.
- **Mount/Demount Arm**: A rotating arm with a tyre-iron attachment facilitates easy removal and installation of the tyre.
- **Clamping System**: A secure three-point locking mechanism holds the wheel firmly during operation, preventing movement and slippage.
- **Ergonomic Design**: Non-slip grips and an adjustable working height reduce user fatigue and improve operational efficiency.

3.2 Construction:

A tyre changer machine makes it easy to mount and demount tyres from car wheels. It is an important tool in garages and tyre shops. The mechanism starts with the bead breaker. It is an important part of the tyre changer. It separates the tyre bead from the rim(Fig a).
After separating the tyre, the wheel is held in place on a turntable with clamps.The turntable rotates the wheel. This lets the operator use tools to remove the tyre from the rim (fig b). The tools include tyre bars and spoons. It must be done carefully to avoid damage.



a. Tyre Bead Breaking Process **b. Tyre Removing Process**

Fig. Block Diagram of manual operated tyre changer

3.3 Fabrication Process

The fabrication of the manual tyre changer involves several key processes, ensuring durability, efficiency, and ease of use. The materials used primarily include mild steeldue to its high strength and cost-effectiveness.

The fabrication process is divided into the following stages:

1. Material Procurement

Mild steel sheets, pipes, bolts, fasteners, and rubber grips are sourced according to the design specifications. The selected materials provide structural stability and resistance to wear.

2. Cutting and Shaping

Precision cutting is performed using plasma cutting, laser cutting, or mechanical saws to shape the base, bead breaker arm, mounting arm, and support structures. Holes for fasteners and joints are drilled to ensure proper assembly.

3. Welding and Assembly

The base structure is welded to provide a stable foundation. The bead breaker lever is attached using a pivot joint, allowing controlled force application. The mount/demount arm is assembled with a rotating mechanism to facilitate easy tyre removal and installation.

4. Surface Treatment

To enhance durability and corrosion resistance, the entire structure is powder-coated or painted with anti-rust coating**.** Rubber grips are installed on handles for better ergonomics.

5. Final Testing

The fabricated manual tyre changer undergoes load capacity, usability, and durability tests to ensure safe and efficient operation.
This fabrication process results in a cost-effective, user-friendly, and long-lasting manual tyre changer, suitable for small workshops and individual users.

4. Future Scope:

The manual tyre changer can be further improved by integrating hydraulic or pneumatic assistance to reduce manual effort, making it more efficient for larger or low-profile tyres. Adjustable height and ergonomic enhancements can improve user comfort, while the use of lightweight materials like aluminum alloys can enhance portability. A foldable or modular design can increase convenience, and expanding compatibility for motorcycles, trucks, and SUVs will broaden its usability. Additionally, mass production and commercialization can make the device more affordable and accessible. These improvements will enhance the efficiency, durability, and adaptability of the manual tyre changer for diverse applications.

5. Conclusion

The design and fabrication of a manual tyre changer provide a cost-effective, efficient, and user-friendly solution for tyre removal and installation. The proposed system addresses the limitations of traditional manual methods, such as excessive physical effort and the risk of tyre or rim damage, while offering an affordable alternative to expensive automated machines. The developed tyre changer incorporates a lever-assisted bead breaker, a stable clamping system, and an ergonomic mount/demount arm, ensuring ease of operation and durability. The use of mild steel enhances structural strength, while surface treatments such as powder coating improve longevity and corrosion resistance. Testing and evaluation confirm that the fabricated system significantly reduces manual effort, enhances operational stability, and improves efficiency compared to conventional methods. The manual tyre changer is particularly beneficial for small workshops, roadside mechanics, and individual vehicle owners who require a reliable and budget-friendly tool.

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