



REVIEW ON DESIGN AND DEVELOPMENT OF MULTI-SPINDLE POWER OPERATED LUG NUT REMOVER AND TIGHTENER

¹Om A. Nawkar ² Tejashri A. Sonawane ³ Akash A. Madhekar ⁴ Omkar D. Maske

⁵ Prof. S. B. Dhotre ⁶ Prof. A.P.Pandhare

^{1,2,3,4}B.E Student, ⁵Assistant Professor, ⁶ Head of Department in Mechanical Engineering Department

Sinhgad College of Engineering, Pune, Maharashtra, India.

Abstract : In essence, most cars fix their wheels with 4–5 lug nuts. The locking lug nuts must be unscrewed one at a time using a lug wrench in order to change a car's wheel tyre the old-fashioned method. However, it can occasionally be very time-consuming and exhausting. The purpose of this project is to develop and construct a hand-operated tool for tightening and removing four wheel nuts at once. The number of cars experiencing tyre failure has increased since there are more cars on the road. For example, a spare tyre can be replaced with a jack and a tool to remove the wheel nuts from the tyres. Nevertheless, in order to save time and remove the nut, applying torque is tough. We create tools with planetary gear mechanisms. In our project, we aimed to minimise the amount of labour required to fix all of the 100mm PCD wheel nuts at once. The major goal of the study is to create a single tool that can be used for both wheel assembly and wheel disassembly. No matter the vehicle model, it can be utilised effectively as a standard tool. Additionally, service stations, workshops, and garages can use it. The remover is made to be easy to handle, easy to maintain, easy to store, and capable of removing all nuts at once.^[3]

Keywords : Planetary, PCD

1. INTRODUCTION

CAR is no longer a sign of affluence. Each and every family needs it. There are several reasons why people require cars. Some of these include travelling conveniently, getting daily tasks done, and moving objects farther away. The issue with tyre punctures is the one that arises most frequently while driving. A spare tyre has to be used in place of the punctured tyre. Drivers must therefore have a basic understanding of how to replace tyres if this situation arises. One needs only the bare minimum of abilities to change a tyre. Almost every car comes equipped with tools for changing tyres, such as an L-shaped nut remover and a jack provided by the manufacturer.

A multi-nut remover is a specific tool used to quickly and easily screw and unscrew the four tyre nuts. Although there are several ways to extract nuts, each one must be removed individually and with a lot of work. With the aid of a multi-nut remover, we may simultaneously tighten and loosen all the nuts while using the least amount of torque. When torque is supplied at the main gear, we will receive the same torque as output for a combined operation because of the way the gears are placed for the sprockets. The goal of the project is to create a mechanism that can be utilised as a standard tool included with a new car. It can be utilised for auto assembly, workshops, and service facilities. The design is straightforward, practicable, affordable, and meets all design criteria.^[5]

2. LITERATURE REVIEW

Prof. AS Udgave: The author attempts to research attachments for the radial drilling machine in this paper in order to turn it into a specific purpose machine. Two holes can be simultaneously drilled in one setting using a multisindle head. So, we use the fundamental design for the entire project.^[1]

Educator K.K. Powar This essay discusses the analysis of the multi-spindle drilling machine's design. The goal is to reduce the amount of time it takes to drill several holes with various pitch circle sizes in a workpiece. The author of this paper must simultaneously drill 4 holes with varying diameters. Therefore, we gave this thought as we planned to remove 4 nuts at once.^[2]

Prof. Johnson Chacko: In this research, the author aimed to minimise the amount of manual labour required to replace all of the nuts on a 120 mm PCD wheel at once. The major goal of the study is to create a single tool that can be used for both wheel assembly and wheel disassembly. Hand levers are used to produce the necessary torque for loosening the nut.^[3]

Professors R.S. Samre, M. A. Khan, and P. Mishra: In this publication, the authors attempted to research and develop a tool for removing wheel rim nuts with a 100 mm pitch circle diameter that transmits the force needed to loosen and tighten the nuts by a hand lever.^[4,5,6]

Prof. S.N. Kumar: We looked at how the author of this study created a gear planetary system to save time and labour. With a single lever stroke, all four nuts on the tyre with a 112 mm pitch circle diameter can be tightened.^[7]

Prof. Sachin Sharma: This paper discusses research on the creation of a tool that can remove five nuts at once.^[8]

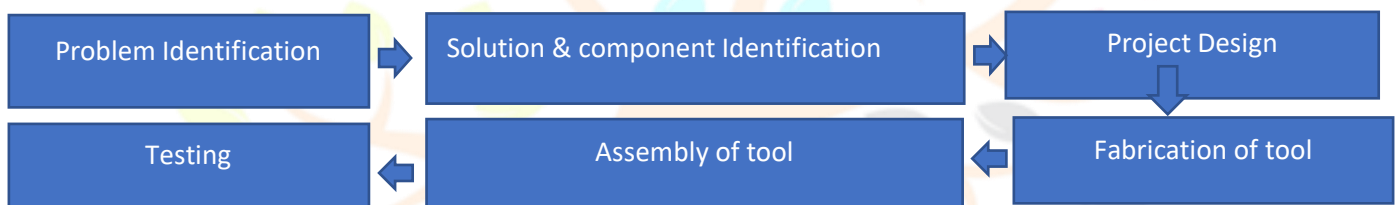
Vaibhav Chowki : The author of this paper attempted to research and design a tool for simultaneously extracting 5 nuts by employing a motor to convey the necessary force.^[9]

3. WORKING PRINCIPLE

Five spur gears are set up such that, by exerting power with the electric motor handle (which is something that anyone can accomplish), the gears will rotate and the necessary torque will then be supplied to the spanners to unlock the four wheel nuts simultaneously. We focused on the application domain—the majority of passenger four-wheelers—in our effort. The primary goal of this endeavour is to create a fully functional assembly that can be used in automobiles. The four output gears that are in mesh with the main gear rotate in the opposite direction as a result of the force applied by the operator's two hands, which causes the centre gear to rotate in the same direction as the handle. To transfer free rotational motion and to provide the correct location of the gears, five bearings are attached at the centres of five gears. By doing this, the four nuts can be opened all at once since the force is eventually transferred to the sockets at the ends of the connecting rods.^[3]

The project must provide the motor with both positive and negative potential. By pressing the switch that corresponds to rotation in the forward direction, we may fix the nut; by pushing the switch that corresponds to rotation in the reverse direction, the provided polarity will be reversed, and we can remove the nut. The operator's needs can determine how the motor is operated. The battery is capable of supplying electricity. To tighten or remove the nut, the operator should lift the model and set it in the proper location.

4. METHODOLOGY



4.1 Identifying the issue: Traditionally, a car's wheel nuts are taken off and individually tightened using impact wrenches or by hand. Both time and effort are needed more for this.

4.2 Solution & Material Selection: If a tool that can remove all nuts simultaneously is developed, the issue of time consumption and the need for additional effort should be resolved. When choosing a gear material, there are three things that matter most. They include cost, which takes into account both the cost of the material and the cost of manufacture, and strength and durability. Various varieties of steel, brass, bronze, cast iron, ductile iron, aluminium, powdered metals, and plastics are just a few of the materials that can be used to make gears. Overall, steel is the most prevalent material, though we have noticed this throughout time with all of the previously mentioned material kinds. A high strength-to-weight ratio, great resistance to wear, the ability to improve the physical qualities through heat treatment, and competitive pricing make steel one of the most sought-after materials. The shaft and gear are made of mild steel.

4.3 Project Design: After considering several aspects, the tool's fundamental design is chosen.

4.4 Fabrication: The pitch circle diameter of the wheel nuts is taken into consideration when making the four spur gears and a pinion gear. According to the reference, the gears have a 58 mm pinion diameter and a 63 mm spur gear diameter. The foundation plate is then constructed to support these gears, and the gears are attached to it. The connecting shafts are then constructed and mounted to each of the four spur gears separately. Therefore, all four shafts revolve along with the spur gears. There are permanent box spanners at the ends of each shaft. The electric motor is then coupled to the pinion gear, which is powered by two 12V batteries. As a result, when the power is turned on, the motor turns the pinion gear, which rotates the four mesh gears. As a result, the shafts attached to the mesh gears rotate as well, as do the nuts that are fixed at the ends of box spanners.

4.5 Assembly: The parts are put together to create the finished prototype.

4.6 Testing: Testing makes sure the model is operating as intended.

5. MECHANICAL DESIGN

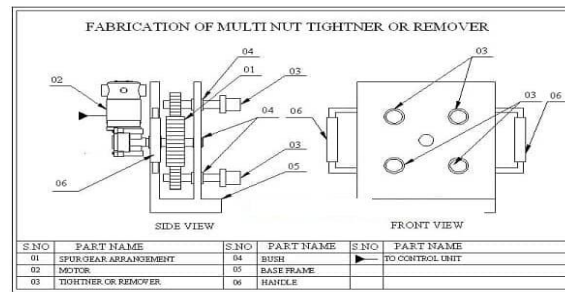


Fig.5.1 Mechanical Design

Above is a draught of the CADD model. Using CADD modelling, the model's side view is being created.^[7]

6. ANALYSIS

The actions taken during test

1 are listed below. SOLID WORKS is utilised as the modelling programme.

2. We constructed our model based on the parameter that was chosen.

3. They employed ANSYS as their analytical tool for the very next stage.

4. To do this, we first meshed our model properly.

5. We determined the equivalent stress and deformation in our model based on the required torque.

6. Consequently, we could tell that our model was secure.^[4]

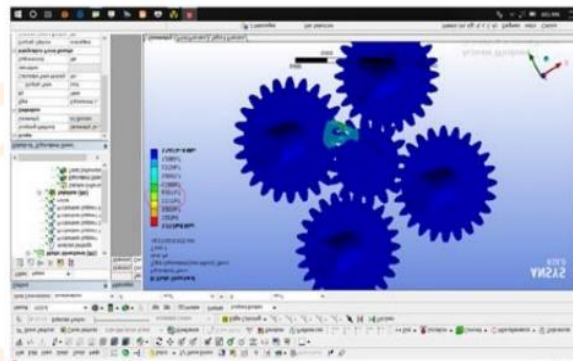


Fig.6.1 Analysis of gear

7. COMPONENTS USED

7.1 Spur Gear

Technical information: Gear diameter is 64 mm, pinion diameter is 54 mm, and there are 22 teeth on the pinion.



Fig.7.1 Spur Gear

7.2 Spanner Socket

The box design of the second type of socket wrench is extremely similar. The socket wrench's head, which matches the nut or bolt head cover exactly, and the handle's flexible sense. The socket has an estimated hexagonal dimension and is either square or of a hexagonal shape. Technical specifications: M19.



Fig.7.2 Spanner Socket

7.3 Base Plate :

The gear base plate is used to support the gears and the shaft extension in order to maintain the forces and methods. This plate is constructed of cast iron. Plate is made of mild steel.

Technical specifications – size = 300*300 mm, Thickness of plate = 10 mm.



Fig.7.3 Base Plate

7.4 Shaft :

A shaft is a spinning machine component with a typically circular cross section that transfers power from one part to another or from a machine that generates power to a machine that consumes power.

Technical specifications : Diameter of shaft = 16 mm, Length of shaft = 150 mm



Fig. 7.4 Shaft

7.5 Bearing :

A ball bearing is a specific kind of rolling-element bearing that employs balls to keep the bearing races apart. A ball bearing's primary purposes are to lessen rotational friction and to support radial and axial loads. In order to confine the balls and transport the stresses via the balls, at least three races are used.^[4]

Technical specifications : Bore diameter = 16 mm, Diameter of bearing = 40 mm.

7.6 Motor :

Like magnet poles repel one another, while unlike magnet poles attract one another, which is the basis for a DC motor. An electromagnetic field centred around a coil of wire that has current flowing through it is produced. It is possible to turn on or off the magnet field of a coil by adjusting the current flowing through it.

8. APPLICATIONS

- Automobile workshops
- Automobile manufacturing units
- Garage, junkyards

9. LIMITATIONS

- 1) The tool can open or close 4 nuts at a time only of 100 mm PCD vehicles.

10. FUTURE SCOPE

- 1) The project, which is entirely mechanical, has been constructed. All actions are taken by hand. Our idea needs a motor to be even more effective as a tool, so the drive must be connected to the motor.
- 2) To design and create the entire assembly of the multiple-operated spanner that will be attached to all of the vehicle's wheels by modifying the pitch circle diameter by making the pinion gear small or large in accordance with the wheel's pitch circle diameter.
- 3) By substituting different gear arrangements for the motor in such a way that it can be manually driven by a hand lever with less power needed. By employing a foundation plate made of a lightweight material, the model's weight can be decreased.
- 4) It is also advised to use alternate gear combinations to operate it with less power.

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