

## Design and Fabrication of Car Wheel Multi Nut Remover

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### Abstract

The aim of this work is to design and fabricate a hand operated tool used for screwing and unscrewing of car tire nuts which is known as Multi Nut Remover. Mostly, the tire nut remover and a jack are provided with car for tire replacement. But, due to difficulty in applying required torque and to save consumption of time, we have successfully developed a multi nut remover which is having a gear mechanism. The Modelling of Multi Nut Remover is done in SOLIDWORKS 2017 Software and later experimental setup was fabricated. After performing various Experiments on Multi Nut Remover experimental setup we came to know that the torque required to remove all nuts and time are less compared to jack and other tire replacement techniques. So, this Multi Nut Remover can find its application in garages, workshops and service stations. The multi nut remover is designed to be ergonomic, easy maintenance, easy storage and easy to handle. This tool is tested and found suitable for various field applications.

**Keywords:** Nut Remover, Gears, Spanners and Nuts & Bolts.

### 1. Introduction

CAR is not a symbol of luxury anymore. It is a need for every family. People need car due to several reasons. Some of them are, to go to a destination, to travel conveniently, to do daily job and to move things to a greater distance. The problem occurs the most during car operation is the problem with tire puncture<sup>1,2</sup>. The punctured tire needed to be replaced with spare tire. Therefore, drivers need to know basic knowledge of tire replacement procedure if such problem occurs. In order to change the tire, one requires minimal skills. Virtually every car has a tire replacement tools such as the L-shaped nut remover and jack supplied by the manufacturer<sup>3,4</sup>.

Multi nut remover is a special purpose tool used to screw and unscrew the four nuts of tire in one time less effort. Although various operations of removing the nuts exists but they require a lot of effort remove single nut one by one. With the help of multi nut remover we can screw and unscrew all the nuts simultaneously by applying minimum torque. Gears are arranged for sprockets in such a manner that when torque is applied at main Gear, we will get the same torque as output for combined operation. The objective of work is to develop a mechanism in one assembly, which can be used as a standard tool provided with a new vehicle. It can also be used for assembly of automobiles, workshops and service stations. Design is simple, easily workable and economical and satisfies all the aspects of design considerations.

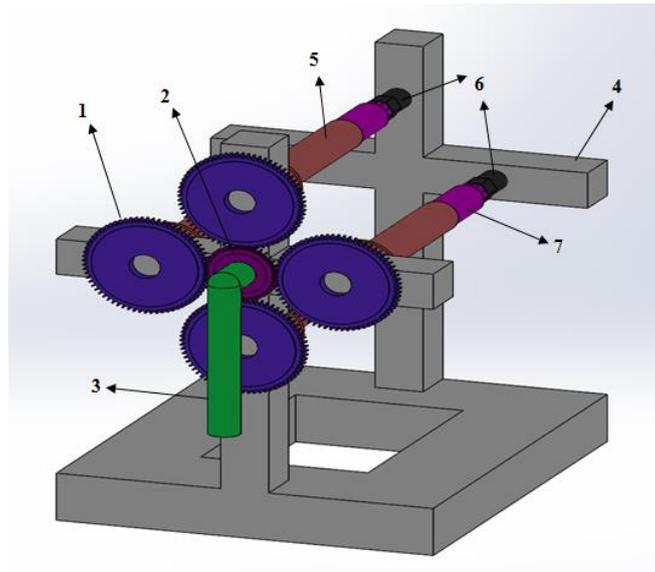
## 2. Designing

The multi nut remover used to open the wheel nuts is designed for ergonomic, easy to handle and requires small space for storage. However, it is difficult for women and the elderly drivers due to high required torque to remove the nuts of the tire. If the nuts are successfully removed, the problem to retighten the nuts will arise. If the required torque is not applied in tightening the nuts, they will get loose, and this will endanger the driver's safety. This tool can also function as tire nuts tightener. Impact wrench which is commonly used for removing of tire nuts is also a time-consuming tool. For these reasons, to avoid wasting of time and energy, a special tool is designed and fabricated to allow driver or mechanic to remove four nuts of tire at simultaneously with little energy consumption. The design is based on standard pitch circle diameter for most of the cars available<sup>5</sup>.

For designing of multi nut remover the basic fundamental of law of gearing have to be followed in designing of gears. The fundamental law of gears state that, for a pair of gear to transmit constant angular velocity ratio. The tooth profiles of these mating gears must be designed in such a way that the common normal line or the line of action passes through a fixed point, or also known as the pitch point, on the lines of the centres. The tire nut removal has been designed with 100mm pitch circle diameter PCD.

### 2.1 Modelling

In order to fabricate the various parts of Multi Nut Remover correctly we need to design the model in Modelling Software. So, we have used SOLIDWORKS 2017 as suitable CAD software for designing the tool. First, we have modelled all parts like Frame, Driver Gear, Driven Gear, Sprockets, Handle, Shafts, Bolts, Nuts, Spanners according to dimensions using various sketch entities and features in part drawing and then all these parts were assembled using constraints under the mate option in assembly Drawing. The complete assembly of all Modelled Part as shown in Fig. 1.



**Figure 1:** 3D Solid Model of Multi-Nut Remover

### 3. Parts

One of the key design decisions that greatly increase the performance and reliability of any machine is selection of the material. We first conducted a market survey to have idea about the availability of material. Based on our market survey we have chosen the following materials listed in the Table 1.

**TABLE 1: MATERIAL USED**

S.No	Item	Quantity (No's)	Dimensions (cm)	Type of Material
1	Spur Gear	4	12	Mild Steel
2	Pinion Gear	1	5	Mild Steel
3	Handle	1	22.5	Galvanized Steel
4	Frame	2	35	Iron
5	Shaft	4	19.5	Iron
6	Nut bolts(Shaft)	4	5	Aluminum & ASTM

7	Nut bolts(frame)	4	10	Aluminum & ASTM
8	Spanner	4	10	Tool Steel

### 3.1 Gears

A gear (or) cogwheel is a rotating machine element having cut teeth, or cogs, which mesh with other toothed part to transmit torque, geared devices can change the speed, torque & direction of a power source. Gears are shown in Figure 2 and Figure 3.



**Figure 2:** Driven Gears, **Figure 3:** Driver Gear

Gears almost always produce a change in torque, creating a mechanical advantage, and thus may be considered a simple machine.

### 3.2 Handle

A vehicle lifting jack of the actuating screw type is provided with an integral showable crank. The crank comprises an L-shaped member pivotally connected to a crank handle as shown in Figure 4.



**Figure 4:** Handle

These elements are foldable and can be swung over the lifting jack for storage.

### 3.3 Frame

A frame is often a structure system that supports other components of a physical construction and or steel frame that limits the construction's extent as shown in Figure 5.



*Figure 5: Frame*

### 3.4 Shaft

A shaft for transferring torque is used to transfer the torque from the spur gear manually to the spanner to remove the nuts as shown in Figure 6.



*Figure 6: Shafts*

Four shafts are connected to the four spur gears individually and at the end of each shaft each shaft box spanners are attached to it.

### 3.5 Spanners

A spanner consisting of a steel cylinder with a hexagonal end that fits over a nut used specially to turn nuts in positions that are difficult to access as shown in Figure 7.



*Figure 7: Spanners*

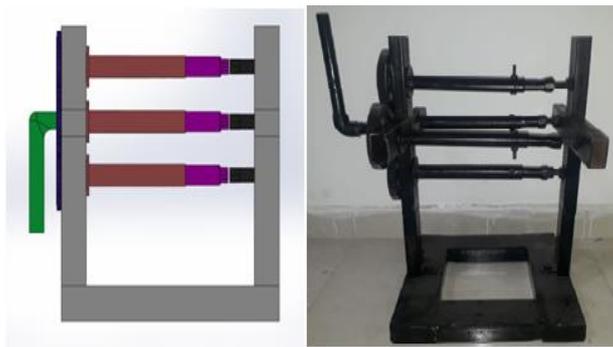
## 4 FABRICATION

A Device for screwing or unscrewing tightly the fixing bolts of a wheel of a vehicle. Which is directly coupled to the wheel, comprising a housing in the form of a parallelepiped, a socket wrench and a sleeve fixed at the end of an adjustable arm. Here, the socket wrench engages a fixing bolt of the wheel to be screwed, the sleeve guaranteeing the stability of the housing of the device during the loosening or tightening of the above-mentioned bolt, by engaging another fixing bolt of the wheel. The housing contains a reduction gear assembly letting to loosen tighten the bolt, by rotating a crank with minimal effort. Multi nut remover consists of one small input gear and four bigger output gears. All main individual parts of are shown in Figure 8.



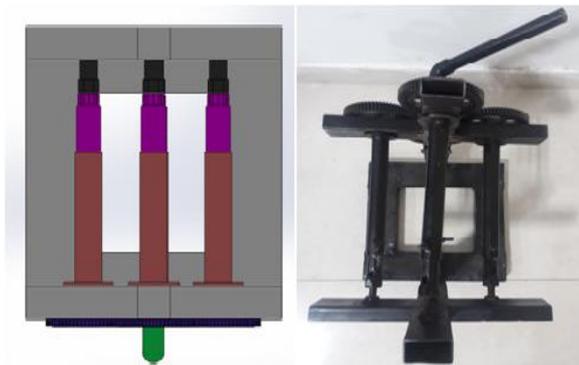
*Figure 8: Components Used.*

The handle which is rotated by the operator is connected to the smaller central gear which is mounted on a bearing as shown in Figure 9 and Figure 10.



*Figure 9: Side View of Solid Model. Figure 10: Experimental model Side View.*

The sockets by which the wheel nuts are getting opened are connected to the four bigger gears by using extension rods. Slots are made on the frame in such a way that the multi nut remover can be adjustable for opening tires which are having different centre to centre distances as shown in Figure 11 and Figure 12. A supporting frame is kept below the gears to constrain the linear motion of the gears. The base plate and the supporting plates are connected by bolts and nuts. Spacing between the gear and plate is given by using washers.



*Figure 13: Top View of Solid Model. Figure 14: Experimental model Top View.*

The housings of the tool are made of low carbon steel. A standard shaft for socket holder is cut and welded on the driven gears. Grease is used to reduce wear, tear and heat due to friction in mating

gears. Once the tool is assembled, a layer of paint is applied to finish the surface and protect from corrosion.

## 5 EXPERIMENT

Once the tool is ready, an experiment is performed with the intention to find out the time required for removing the nuts. Experiment using impact wrench is also performed.

Experiments were conducted on the wheel of Maruti Suzuki Swift. An impact L shaped wrench is used to remove all the nuts. The torque applied by wrench is 375 Nm to remove all nuts in 102 seconds then the application of multi nut remover in removing all wheel nuts is also recorded. The torque applied by multi nut remover is about 7N, 10N, and 12N. The time taken to remove wheel nuts using multi nut remover is 90 seconds.

## 6 RESULT AND DISCUSSION

We have conducted various experiments and we came to know that the torque, required to screw and unscrew the tyre nuts are 33% less when compared to another spanner and wrench method. The torque applied is reduced using multi nut remover for removing four nuts at once is faster than removing one nut at a time. The reduction in time taken is about 53%. Testing of tools was done successfully, we can use this tool to remove wheel easily.

## 7 CONCLUSIONS

The design and fabrication of multinut removing tool is proposed. The fabrication of tool is completed by welding and fitting processes. The tool is successfully fabricated and fully functional and tested manually using lever.

From the results of experiments, the tool is possible to be improved and prototyped for mass production. For future development and improvement of the tool, light weight and high strength material is expected to be available and applied.

We have reduced the effort or torque for removing nut but future work can be done on this project in order to reduce human effort completely by replacing manual drive by motor drive.

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