IJCRT.ORG ISSN : 2320-2882

INTERNATIONAL JOURNAL OF CREATIVE RESEARCH THOUGHTS (IJCRT)

An International Open Access, Peer-reviewed, Refereed Journal

Design and Development of Multi-Nut Tightener

Ananthu P[1], Dileep P I[1], Johnson Chacko[1], Sammon S[1],
Mathew Mathew[2]
UG Students[1], Assistant Professor[2] Department Of Mechanical Engineering
Mount Zion Institute of Science and Technology Chenganuur, Kerala, India

ABSTRACT

Essentially, most of cars use 4 to 5 lug nuts to fix wheels on cars. The traditional way to change a car's wheel tire is to unscrew the locking lug nuts one by one using a lug wrench. However, sometimes it can be so exhausting and time consuming. In this project our aim is to design and fabrication of four wheel nut removing hand operated tool for tightening and removing of four nuts in one stroke. With the increment of number of car on the road, the number of cars problem due to tyre failure has increased. Often, the car is provided with tyre wheel nuts remover and jack for instance spare tyre replacement. Nevertheless, due to difficulty in applying torque to remove nut and to save a time. We develop tool having a gear planetary mechanism. In our project we are tried to focus on the minimization of human effort for fixing all for nuts of 120mm PCD wheel in one time. The main objective of work is to develop a single tool, which can be made use during assembling and disassembling of wheels in automobiles. It can be successfully used as standard tool irrespective of the model of the vehicle. Also it can be used garages, workshops and service stations. The remover is designed to be ergonomic to be used, easy maintenance, easy storage, easy to handled and able to remove all nuts at once.

INTRODUCTION

Vehicle is an important machine in human daily life. Nowadays, each family has at least one car to make the transportation easier and faster. For a car, the tool set-up for each vehicle is a T-nut wrench and car Jacky which is hard to use for a women or teen to open their car's nut. One of the problems of a vehicle is tire problem.

If the vehicle tires have some problem then the user must remove the tires and fix the problem. And for a car user, it's difficult to remove tire's nut especially for women users. The disadvantages are waste of time and force needed. In India and other countries automotive market there is no tool that is easy to use to remove the nuts. The time to open a car's tire nut is too long and the car user's time is wasted with utilization of high force and especially this is big hurdle for women users.

To overcome the waste of time and high force needed, a tool have been designed to remove four nuts of a tire in single time with decremented applied force. 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. 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 accurate tensioning of a screw is necessary. It has moreover been found that, at the high speeds used, ratchet couplings also apply a powerful shock action and are therefore likewise unsuitable for tightening expansion screws.

Engineering in general, and Mechanical engineering in particular, deals with a wide spectrum of products, ranging from large and complex systems comprising of numerous elements down to a single component. The service offered by an automobile maintenance and repair.

Garage would be a typical example from mechanical Engineering. Even computer software could be treated as an engineering product.

It is also created using engineering knowledge and skills. In the following, the term product when used alone denotes the object to be designed and made with the help of engineering knowledge and skills, irrespective of whether it is a large system, a simple machine, a component or a service. A complex product can be sub divided into sub-assemblies or sub system, component etc. Frequently the planning, layout and design of a complex multi element product is an interdisciplinary effort, requiring the expertise and skills not only of several engineering specialization but even non engineering ones. It is always preferable that our work should be easy and fast. But easy and fast working requires some technical skills to work efficiency and properly.

In a day-to-day life there are many problems where there is a need of lot of effort and time to do that specific work. A little but important work that all people would do often is opening a wheel of a vehicle. It is a fact that a huge effort is required to open a single nut of a car wheel and it will become a tedious task to open the wheel in extreme atmospheric conditions.

It also creates problem when there is an emergency situation. Here is the solution to the problem mentioned above by Adjustable Unified Wheel Opener, it is a special tool designed for opening a wheel with ease.

It is so designed that it can open all the four nuts of a car wheel in one time. And the most desired achievement is that, the total effort and time needed in the process is very less. It can open and also refit the wheel with the same tool.

LITERATURE REVIEW

The main purpose of using gears is to transfer power from a source to an application. Moreover, the modern technology of gears in its current form ages backs to only 100 years ago. Nevertheless, the oldest form of gears can be traced back to fourth century B.C. Greece. In addition, there are a lot of application that involves gearing systems in them such as, robotics, automotive and power transmissions. Moreover, there are different types of gears that can be used such us, bevel gears, helical gears and spur gears. In this project, the gear train that is being used is consisting of spur gears that are meshed in a way to achieve the aim of this project that is to design and manufacture an automotive tire changing mechanism. Nut remover is the most widely used in the field of vehicle.

Normal when we have to fix our four wheelers tyre issue we use torque wrench or spanner to deal with its nuts. But with this system one can open or tighten a nut, but only one at a time. Every car manufacturer provide tool for doing so. Emergency puncture the wheel of the ambulance, it will be a time-consuming. To handle such issue we propose a tool " MULTI NUT TIGHTENER'' a tool who can open all four nuts of wheel of a four wheeler simultaneously and in a time saving manner. To do so we used gear mechanism, with one main gear and four pinion gear and spanner depending on BCD (bolt circle diameter) are mounted over pinion in such a manner that when main gear rotate it transmit motion and power to pinion and with pinion spanner to rotate. Now arrangement and size of gears used is depending on PCD (Pitch circle diameter) of wheel and nut location. Which make it user friendly, convenient and time efficient tool.

Some of the references taken are M. Mukhtar, M.H.P Hilmie Hussaine, 2014, Design Improvement and Computer Assisted Fabrication on the Impact Wrench for a Car Wheel Nuts Puller in Automotive industry, Australian Journal of Basic and Applied Science, Vol.1, Issue 3, ISSN: 2320-401X, pp. 381-384.Azizul Rahman B Abd Aziz, 2008, Improvement and Optimization of Wheel Nut Remover with 114 PCD". University of Malaysia, Pahang.

This reference helped us to develop our model for 100 PCD. IJSRD - International Journal for Scientific Research & Development Vol. 3, Issue 02, 2015 ISSN (online): 2321-0613 Design & Fabrication of Four Wheeler Opening Spanner had a published a paper for adjustable one.

M Gopi Krishna, K. Praveen Kumar, J.Babu Rao, NRMR Bhargava, K.Vijaya Bhaskar, "Deformation Studies on A2024/ Fly ash/ Sic Hybrid Composites", International Journal of Engineering Research & Technology, vol. 2, Issue 10, 2013, pp. 3772-3776.

M. Harika, G. Rajeswara Rao, M Gopi Krishna, "Design Modelling And Finite Element Analysis of Double Helical Gearing System For High Speed Compressor Engines" (IJITR) International Journal of Innovative Technology and Research Volume No.4, Issue No.6, October – November 2016, 5051-5054

CONSTRUCTION

Nut tightener consists of one small input gear and four bigger output gears. The handle which is rotated by the operator is connected to the smaller central gear which is mounted on a bearing. The sockets by which the wheel nuts are getting opened are connected to the four bigger gears by using extension rods. Slot are made on the plate in such a way that this machine can be adjustable for opening tires which are having different centre to centre distances. A supporting plate is kept above the gears to constrain the linear motion of the gears. The base plate and the supporting plates are connected by bolts and nuts.

Fig. multi-nut tightener

WORKING PRINCIPLE

Five spur gears are arranged in such a way that, by applying 200 N of force with both the hands on the handle (which any normal person can do), gears will be rotated and finally required torque will be applied on the spanners to open the four wheel nuts at a time. In this work, we concentrated on the application domain i.e., most of the passenger four wheelers.

The main objective of this work is to develop a complete mechanism in one assembly, which can be used in automobiles. This machine is operated by an operator by applying force by using both the hands, due to which the central gear rotates in the same direction as the handle and by this motion the four output gears which are in mesh with the main gear rotates in opposite direction to the first. Five bearings are attached at the centres of five gears to transmit free rotational motion and to give the exact position to the gears.

By this finally the force is transmitted to the sockets at the end of the connected rods, and thus the four nuts can be opened at once. Generally, spur gears are used for transmitting power between non parallel intersecting shafts. So spur gear arrangement is used for actuating the four socket spanners at a time. Twelve driven gears and one pinion gear are used. The cam and follower mechanism is used for making the project adjustable. For this purpose radial cam is used because the follower moves in the direction perpendicular to the cam axis. And spherical face follower is used because the side thrust and wear is considerably low.

The pinion gear is meshing with four auxiliary gears which are in turning connected to a gear whose axle containing the socket spanners at its end. The auxiliary gear connected to a hollow shaft (main shaft) which is acting as a guide for follower. The other end of the follower is connected to a bevel gear. A lock nut arrangement is provided for connecting the main shaft to follower at any desired position.

COMPONENT DETAILS

SPUR GEAR

Spur gears or straight-cut gears are the simplest type of gear. They consist of a cylinder or disk with teeth projecting radially. Though the teeth are not straight-sided (but usually of special form to achieve a constant drive ratio, mainly involute but less commonly cycloid), the edge of each tooth is straight and aligned parallel to the axis of rotation.

DESIGN CALCULATIONS

Circular pitch = p = πd/z

Diametric pitch = P_D = z/d

Module = m = d/z

Pitch diameter = d = mz

Base circle diameter = db = $d \cos \alpha$

Dedendum circle or root diameter, dr

$$= d - 2\,(\,tf + tc - k')m$$

Addendum circle or outside diameter, d_r

$$= dr + 2h$$

Power transmitting capacity, p

$$= f_t v / 1000$$

Equation for strength of tooth

$$= \sqrt{f_t / (\sigma d\ cv\ ky)}$$

No: of teeth of driver gear = 22

No: of teeth of driven gear = 30

PCD of driver gear = 50mm

PCD of driven gear = 60.5mm

External diameter of driven gear = 70

External diameter of driver gear = 60

Gear ratio = no. of driven gear/ no.of driver gear

$$= 30/22 = 1.36$$

Diametric pitch = no.of teeth / PCD

Driver gear = 22/50 = 0.40mm
Driven gear = 30/60.5 = 0.49mm

Addendum of driver gear = 1/0.40

= 2.5mm

Addendum of driven gear = 1/0.49

= 2.04mm

Dedendum of driver gear = 1.250/0.40

= 3.125mm

Dedendum of driven gear = 1.250/0.49

= 2.55mm

Tooth depth = addendum + dedendum

Tooth depth of driver gear

$$= 2.5 + 3.125 = 5.625$$

Tooth depth of driven gear

$$= 2.04 + 2.55 = 4.59$$

Root diameter of driver gear

= PCD - dedendum

$$= 50 - 3.125 = 46.875mm$$

Tip diameter of driver gear = PCD + dedendum

$$= 50 + 2.5 = 52.5mm$$

Torque required loosening 1 bolt

$$= 94.187N/mm$$

Torque required for loosen 4 bolt

$$= 4 \times 94.189 = 376.74Nm$$

BOX SPANNER SOCKET

The second type socket wrench is a box design is very similar. The head of the socket wrench that is completely the same as the nut / bolt head cover and the sense of the handle not fixed. The socket is a hexagonal shape or size estimate which itself is either a square.

BASE PLATE

In order to keep the forces and means of the gear base plate is used to withstand the gears and the shaft extension. To remove the weight and increases the stability of the device. This is a plate made of cast iron. Mild steel are selected for plate.

SHAFT

Shaft is a rotating machine element, usually circular in cross section, which is used to transmit power from one part to another, or from a machine which produces power to a machine which absorbs power.

SHAFT CALCULATION

Torque, $T = 4.55\times10^6 / n$

$= 376.74Nm$

Diameter of shaft = 20mm

Shear stress = $16T / \pi d^4$

$= 16\times376.74 / \pi\ 20^4 = 0.2398Nm$

Angle of deformation θ

$= 584TL / Gd^4$
$= 584\times376.74\times100 / 78.5\times10^3\times20^4$

$= 1.751$

LEVER

A handle is a part of, or attachment to, an object that can be moved or used by hand. The design of each type of handle involves substantial ergonomic issues, even where these are dealt with intuitively or by following tradition. Handles for tools are an important part of their function, enabling the user to exploit the tools to maximum effect. Package handles allow for convenient carrying of packages.

BEARINGS

A ball bearing is a type of rolling-element bearing that uses balls to maintain the separation between the bearing races. The purpose of a ball bearing is to reduce rotational friction and support radial and axial loads. It achieves this by using at least three races to contain the balls and transmit the loads through the balls.
As one of the bearing races rotates it causes the balls to rotate as well. Because the balls are rolling they have a much lower coefficient of friction than if two flat surfaces were sliding against each other. Ball bearings tend to have lower load capacity for their size than other kinds of rolling-element bearings due to the smaller contact area between the balls and races.

BEARING DIMENSIONS

Inside diameter = 15mm

Outside diameter = 35mm

Width = 11mm

Dynamic load = 8.06kN

Static load = 3.75kN

Reference speed = 43000r/min

Limiting speed = 22000r/min

Dimension D_1 = 21.7mm
D_2 = 30.4mm

ADVANTAGES

- Simple in construction.
- Less weight.
- It saves time as compared to other devices.

- It can operate easily.
- No need of skilled operators to operate this system.
- Easy to fabricate.

APPLICATIONS

- Automobile workshops
- Automobile manufacturing units
- Garage
- Junkyards

FUTURE SCOPE

It act as a convenient and simple method for tyre replacement process thus It is more suitable in using this setup for tyre removal in every vehicles for reducing the time consumed and for reducing the man power wasted for the tyre replacement and to overcome the emergency situations. Thus the vehicle multi wheel nuts remover and tightener can be used in all automobile shops and can be carried in each vehicle for instant tyre replacement which saves lot of time and energy for every person.

REFERENCE

[1]. A. R. Abd Aziz "Improvement and Optimization of Tire Nut Removal with 114 PCD". Universiti Malaysia Pahang, Thesis Degree, 2008 Stability Control of Vehicle

Emergency Braking with Tire Blowout by Qingzhang Chen, Youhua Liu, and Xuezhi Li

[2]. M. F. Abd Rahim "Design, Development and Fabrication of Tyre Lug Wrench". Universiti Teknikal Malaysia Melaka (UTeM), Thesis Degree, 2007Analysis Emergency Braking Performance with Particular Consideration of Temperature

Effects on Brakes by Silvia FariaIombriller

[3]. R. Abdul Rahman, C. A. Che Ismail and M. Y. Abdullah "MechanikMesin".

Universiti Teknologi Malaysia Publisher, 2003

[4]. V. Sarkar "Mechanics of Machines". Tata McGraw-Hill, 2004Fabrication of Auto-

Braking System for Pre-Crash Safety Usings Sensor by EungSoo Kim

[5]. Novel clamping force control for electric parking brake systems Mechatronics by Young Ok Lee

[6]. A parametric study of golf car and personal transport vehicle braking stability and their deficiencies by Kristopher J. Seluga

[7]. Design for the Predictor of the Emergency Braking System Based on Fuzzy Algorithm by J. H. Li and H. M. Kim

[8]. Advanced Emergency Braking Controller Design for Pedestrian Protection Oriented Automotive Collision Avoidance System by Guo Lie

[9]. Review on Parking Brake Lateral Play in Four Wheeler by Prof: Wakchaure P.B, Prof:

Borkar B.R 2013

[10]. Design & Analysis of Master Cylinder of Hydraulic Braking System Using ANSYS byJ.Reddaiah, Dr. G. HarinathGowd, S. Praveen Kumar, V. Vishnuvardhan 2013

[11]. K Praveen Kumar, M Gopi Krishna, J Babu Rao, and NRMR Bhargava "Fabrication and Characterization of 2024 Aluminium – High Entropy Alloy Composites", Journal of Alloys and Compounds, 640 (2015) 421– 427.

[12]. M Gopi Krishna, K. Praveen Kumar, J.Babu Rao, NRMR Bhargava, K.Vijaya Bhaskar, "Deformation Studies on A2024/ Fly ash/ Sic Hybrid Composites", International Journal of Engineering Research & Technology, vol. 2, Issue 10, 2013, pp. 3772-3776.

[13]. M. Harika, G. Rajeswara Rao, M Gopi Krishna, "Design Modelling And Finite

Element Analysis of Double Helical Gearing System For High Speed

Compressor Engines" (IJITR) International Journal of Innovative Technology and Research

Volume No.4, Issue No.6, October – November 2016, 5051-5054