International Journal of Mechanical and Industrial Technology **ISSN 2348-7593 (Online)**
Vol. 7, Issue 1, pp: (36-40), Month: April 2019 - September 2019, Available at: www.researchpublish.com

DEVELOPMENT OF MULTI-WHEEL NUT REMOVER AND TIGHTENER

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***Abstract*: The purpose of this study is to develop a simultaneous device that can remove five lug nuts at the same time. The scope of this study is to design and select the materials. The procedure of the test will be to set the torque wrench in using the simple lug wrench and the purpose device. The findings show that the device was more convenient than the simple lug wrench. The limitations of this study include the vehicles having 5 lug nuts with 114.3 mm itch diameter. The focus of this device is on removing and tightening of wheel nuts only. This study contributes to the cars users and auto repair shop industry. The study may also be significant to the researchers who would like to do further the research.**

***Keywords*: Lug wrench, Wheel Nut.**

I. INTRODUCTION

Wheel Nut remover and tightener is a device use for the tightening and removing the lug nuts of a car. It is one of the tools that help the drivers and owners to change the nut on their tires when unexpected things happen. This device is a lot of help in terms of changing tires. Today's transportation industry in the Philippines is on its rapid evolution. Cars is used as a daily mode of transportation by most individuals in the Philippines, but sometimes common car problems may occur. One of this is the flat tire caused by sharp objects on the road. These cars are equipped with a jack and an L shaped or T-nut wrench which are tool used in changing tires. Some car owners find it really hard to change because it requires a lot of force and effort just to remove a single nut. These common problems made the researches think a way to simply remove or tighten the wheel nuts.

A design of a wheel nut remover and tightener that has a function of removing five nuts at the same time. This leads to the objectives of designing and creating a wheel nut remover and tightener and prove that using the proposed device, the torque required to remove or tighten the car nut simultaneously will be lower than removing or tightening a single nut. The idea in this project is using a ratio of diameters which will help convert and deliver the smaller torque from the driving gear to the driven gears which will generate a larger torque. The results of this study are both beneficial to the car owner, the mechanic and the future researchers. The only focus of this device is on removing and tightening of wheel nuts. The tool that is designed and created by the researchers is only applicable for vehicles having five lug nuts. Issues other than these such as corrosions, lubricants and/or anything unrelated to loosening and tightening of the lug nuts are not covered in the study.

II. LITERATURE REVIEW

According to Abdullah (2007), transportation has become a necessity. Statistically speaking, almost every family has at least one car for their own transportation. Cars also evolve from steam powered to electronics. In optimal design of industrial products, materials and process selection are key issues to consider. The main gear design criteria are surface fatigue limit index, bending fatigue limit index, surface fatigue lifetime index, bending fatigue lifetime index, wear resistance of toot's flank index and machinability index. Electra is one of the most appropriate models for classification of alternatives for gear materials. (MATERIAL SELECTION IN GEAR DESIGN by Radinko GLIGORIJEVIC Jeremija JEVTIC Djuro BORAK; May 18th year 2008)

The ratio of 3:1 on the input/output rotation, it will at least lessen the torque three times theoretically. The epicyclical gearing is used in having a compact design. According to NOMARK Industries, Inc. (1999-2007), loose wheel nuts occurs when under-torqueing, over-torqueing, differential thermal contraction and improper mating surfaces. Helical gearing is machined with angled teeth, then hardened and ground, which is complex but necessary to achieve a high-efficiency gear mesh. Another advantage of helical gears over spur gears is in torque capacity. (http:// machinedesign.com / mechanical-drives/helical-gears-manufactu- ring-go-green). A gear structure depends on the application, including the gear's service, rotation speed, accuracy and more. There is variety of materials used in gear manufacturing such as cast iron, alloy steel, cast steel, aluminum, brass and copper. According to Rich Ashley on his paper "The Right Torque Procedures" (October 15, 2012), a nut must have an initial torque of a least 50-60 foot-pound before the final torque is applied for a good, snug fit on a car wheel. On some cars, exceeding the torque value by 30-40 foot-pound will ruin the fasteners.

A. Synthesis

Wheel nut remover is designed to help the users during the removal of the nuts when replacing tires. Based on the study done by Radinko GLIGORIJEVIC Jeremija JEVTIC Djuro BORAK about the Material Selection in Gear Design. It is stated that it is difficult to select materials because of the variety of materials available in the market today. But agreeing with the article from globalspec.com, it states that cast-iron steel provides quality in terms of durability and vibration resistance. The design of this apparatus will use spur gears assembly. A gear ration of 3:1 on the input/output rotation, will at least lessen the torque three times theoretically. The researchers used at least 50-60-foot pound as an input data for their calculation. Design of Machine Elements and Elements of Mechanism are used for the references used for the project study.

III. METHODOLOGY

This part of the study represents the research design. In terms of method of research, testing for the effectiveness and efficiency of the apparatus is elaborated. The researchers gathered data from specified documents, studies, books and articles to analyze the materials to be used, to develop a wheel nut remover and tightener. The information collected by the researchers will be used for comprehensive understanding in the development of wheel nut remover and tightener. The researchers developed a device with the use of gears assembly to share the convenience and advantages it could offer to its possible users. This study was conducted at Lyceum of the Philippines University -Cavite during the first semester of 2016-2017. The materials for the device was done in Las Pina's Philippines.

The following materials were the materials used to create the device:

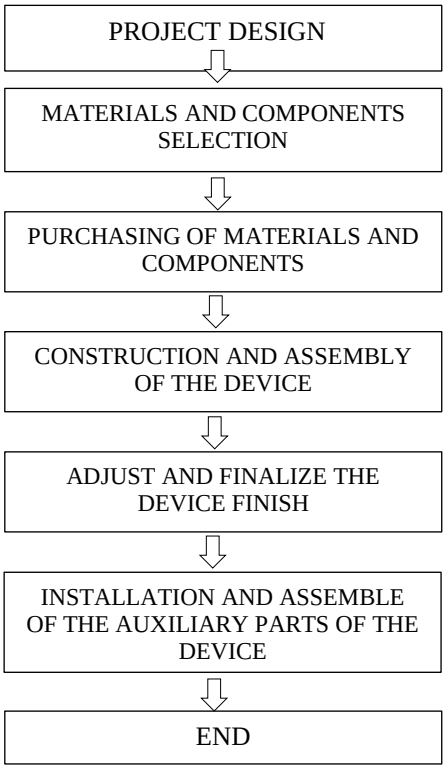
- Helical Gears are circular gears with angled rather than straight teeth
- Shaft is a mechanical component for transmitting torque and rotation.
- Bearing is a machine element that constraints relative motion and reduces friction between moving parts.
- Handle is the part by which the device is held, carried and controlled.
- Mechanical socket is for tightening and loosening nuts of different sizes
- Casing is a cover shield that protects or encloses the device.

The data were gathered by the researches are from books, articles, studies and the internet. Results of the device were analyzed and observed to further understand the project study. Testing and evaluation of the developed device was done with the guidance of their adviser. Different references and procedures were used to gather needed data for the study. The researchers read and analyzed different studies, articles, books, online references related to the study conducted.

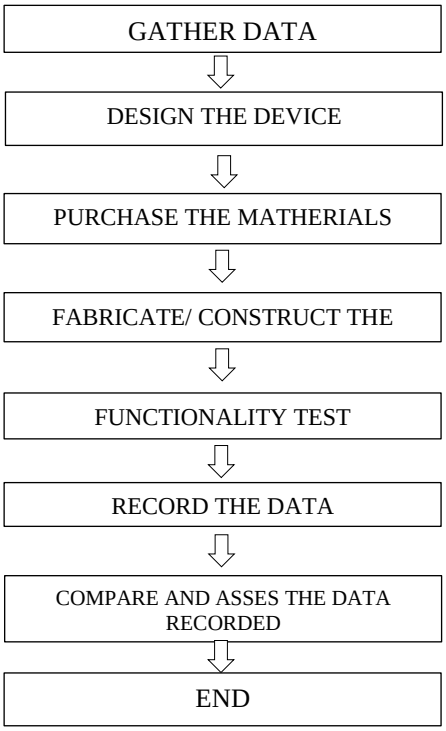
To determine the efficiency of the wheel nut remover and tightener, the following were systematically performed:

- Calculations of the appropriate dimensions and sizes of gears
- Selection of material
- Identifying efficiency of the wheel nut remover and tightener

B. Project Construction Procedure



C. System Model



Project testing: The following were done in testing the device.

Test 1- Loosening the lug nuts.

1. Prepare the torque wrench and the wheel nut remover and tightener for testing
2. Set the torque wrench to theoretical torque needed to loosen the wheel lug nut
3. The group will perform the loosening of lug nuts using the device
4. Record the torque when the lug nut is loosened
5. Repeat testing up to 5 trials
6. Record the testing results

Test 2- Tightening of lug nuts

1. Prepare the torque wrench and the wheel nut remover and tightener for testing
2. The group will perform the tightening of lug nuts using the device
3. Record the torque reading for the torque wrench when the lug nut is tightened
4. Repeat testing up to 5 trials
5. Record the testing results

The efficiency of the wheel nut remover and tightener was tested by means of the torque required in loosening and tightening five lug nuts at the same time. The efficiency of the developed wheel nut remover and tightener was computed by dividing the theoretical input over the actual torque needed.

IV. RESULT AND DISCUSSION

The tables and figures shown below was the data gathered by the researchers from conducting a series of test. The reason why they conducted the testing is to prove that the device is working and to prove that it is better from the old model. The graph shows the difference in the torque of the lug wrench and the multi-wheel nut remover and tightener from the testing conducted by the researchers.

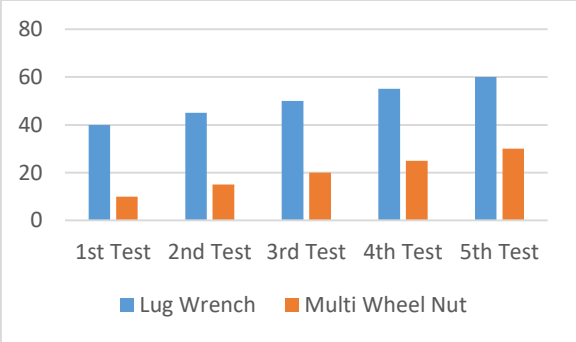


Fig 1: Difference in the Torque of the lug wrench and multi wheel nut remover and tightener

Table 1: Materials Selection

Quality	Cast Iron	Cast Steel
Castability	□	
Ease of machining	□	
Vibration damping	□	
Compressive strength	□	
Impact resistance		□(Stainless alloys)
Corrosion resistance	□	□
Wear Resistance	□(depending on application)	□(depending on application)
Coast	□	

Table 1.1: Standard Gear-Tooth Proportions

System	14 ½ Full-Depth	Driver Gear (Qty.1)	Driver Gear (Qty. 5)
Addendum	1/Pd	0.0625 in. or 1.5875mm	0.0625 in. or 1.5875mm
Dedendum	1.157/Pd	0.0723in. or 1.8367mm	0.0723 in. or 1.8367mm
Clearance	0.157/Pd	0.0098 in. or 2.49mm	0.0098 in. or 3.424mm
Working depth	2/Pd	0.1348 in. or 3.424mm	0.1348 in. or 3.424mm
Total depth	2.157/Pd	0.1348 in. or 3.424mm	0.1348 in. or 3.424mm
Outside diameter	T+2/Pd	1.25 in. or 31.75mm	3.5 in. or 88.9mm
Tooth thickness	1.5708/Pd	0.098175 in. or 2.49mm	0.098175 in. or 2.49mm
Tooth space	1.5708/Pd	0.098175 in. or 2.49mm	0.098175 in. or 2.49mm
Fillet Radius	0.208/Pd	0.013 in. or 0.33mm	0.013 in. or 0.33mm

V. CONCLUSION

The design of the multi-wheel nut remover and tightener is made to reduce the torque of removing the nut by three (3) times smaller, theoretically. The materials that are used to fabricate the device are selected properly. The specification of the gear, casing, shaft and cover are determined to design the proposed device. Machine shop process are applied to achieve the actual dimensions, shape and surface finish of the gear. The multi-wheel nut remover and tightener is manufactured and successfully proven its function. The device is tested and evaluated using torque as the parameter and torque wrench as the device that provide torque value. The device is fully functional using the lever in testing procedures, the device can produce a value lesser than the required which part of our general objective.

VI. RECOMMENDATION

It is possible for the device to be improved and serve as a concept for the future development of the wrench. For improvement and future development of the multi-wheel nut remover and tightener new design for gear assembly or new type of gear can be applied. It is also highly recommended to use lighter and stronger material if possible, to create a more economical device.

ACKNOWLEDGMENT

This undergraduate thesis would not have been possible without the support of many people. It is with immense gratitude that the researchers acknowledge the support of the research adviser and professor Engr. Jestoni Asi and Engr. Arnel Avelino. It also gives them great pleasure to acknowledge Engr. Eduardo Manzano and Engr. Joel Lampaya for the suggestion while planning the design. The researchers would also like to convey thanks to the Faculty for providing the instructions and laboratory facilities.

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