



Faculty of Engineering

DESIGN OF A MULTI-SPINDLE IMPACT WRENCH MECHANISM

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
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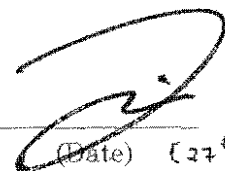
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DESIGN OF A MULTI-SPINDLE IMPACT WRENCH MECHANISM

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This project is submitted as partial fulfilment of the requirements for the degree of Bachelor
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To my beloved family, friends and all who has supported me.

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ABSTRACT

Tyre plays a significant role in the performance of car. Removal of car tyre is a really a difficult task. In order to facilitate easy removal of tyres a simple tool has been designed. Multi-spindle impact wrench is a tool that is able to untightened four (4) lug nuts of a car tyres simultaneously in the same time. This project describes the mechanism of the multi-spindle impact wrench. For this project, it used gearing system consists of one driver of spur gear and 4 pinions of spur gears in a tool. The permissible bending stress of the gear system is able to be calculated by considering all the parameters related to this projects. Besides, the safety factor of the gear is also able to be developed. Safety factor is the ability of a system's structural capacity to be viable beyond its expected or actual loads. It is important to avoid any gear failure in the future. Finite simulation also is being carried out by using Solidworks for stress analysis.

ABSTRAK

Tayar memainkan peranan penting dalam mengekalkan prestasi sesebuah kereta. Penukaran tayar kereta adalah tugas yang sangat sukar. Untuk memudahkan penukaran tayar, satu alat telah direka. *Multi-spindle impact wrench* adalah alat yang mampu membuka keempat-empat (4) *lug nut* dari tayar kereta sekaligus pada masa yang sama. Projek ini menerangkan mekanisme *multi-spindle impact wrench*. Untuk projek ini, sistem gear yang terdiri daripada satu pemacu gear *driven* dan 4 pinions dalam satu alat telah digunakan. Tekanan lenturan yang dibenarkan bagi sistem gear juga boleh dikira dengan mempertimbangkan semua parameter yang berkaitan dengan projek ini. Selain itu, faktor keselamatan gear juga dapat dikira. Faktor keselamatan adalah keupayaan struktur sistem untuk menjadi berdaya maju di luar jangkaan atau beban sebenar. Adalah penting untuk mengelakkan kegagalan gear pada masa akan datang. *Finite simulation* juga telah dilakukan dengan menggunakan Solidworks untuk membuat analisis tekanan.

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CHAPTER 1

INTRODUCTION

1.0 Introduction

In this introduction, background of the project, problem statement, objectives, significance of project, scope of project and outline of the thesis will be discussed. The background of the project is the overview of the project itself in term of definition and the function of the device. While the objective of the project is the main important thing in order to ensure the target of the project is achieved. Significance of the project is about the aim of this project. Besides, the scope of the project is about the products and some other feature that needed or need to give attention in this project. While the outline of the thesis is about the development of the project in every chapter in order to complete this project.

1.1 Background of Project

The impact wrench is a socket wrench power tool that is designed to deliver torque. An impact wrench is an important tool for automotive repair work and designed to provide high torque at a medium speed. This design also means that impact wrenches have a very high power-to-weight ratio. They are also known as impactors, air wrench, air guns, rattle guns, or torque guns. It used a twisting motion in short bursts against the lug nuts that allows to loosen or tighten them. The primary function of an impact wrench is to deliver high torque to nuts and bolts for tightening or loosening lug nuts on tyres.

An impact wrench delivers torque in a series of short bursts created by the impact of a swinging hammer on an anvil. The hammer is connected to the output shaft of a pneumatic or electric motor. While the anvil is connected to the driveshaft of the tool. When the fastener is running free, the hammer and anvil move together. When the socket encounters resistance from the fastener, the hammer rotates independently, striking the anvil once or twice with each revolution of the output shaft, depending on the tool. The impact wrench also will bring additional force and grip to a hard-to-turn bolt.

The impact wrenches usually are used in building and construction projects, tightening nuts and bolts requiring high amounts of tightening torque such as in automotive and heavy equipment maintenance and also product assembly. Impact wrenches are usually handheld but may be mounted on articulating arms for factory assembly applications. In general, impact wrenches are heavier, bulkier, and have more torque compared to impact drivers. It also used a square drive which is generally 1.27cm and are made for loosening or fastening sockets.

Impact wrenches come in a wide range of sizes, from a 0.635cm hex drive, pistol-grip model to 8.89cm square drive, two-handed behemoth. The former weighs 1.09kg of impact wrench has a free speed of 15000 rpm which delivers 1500 impacts per minute and manage to apply a maximum torque of 355 Nm. The latter weighs 271.7kg which has a free speed of 295 rpm, manage to delivers 500 impacts per minute and applied a maximum torque of 108465.4 Nm. The impact wrenches are available in pistol-grip, in-line and D-handled models and the end of the driveshaft can be hexagonal, square or splines.

1.2 Problem Statement

Nowadays, technology really give a big impact in human life. The technology also able to ease and accelerate the work of humans in their daily lives. Examples include washing machines, gadgets and so on.

In today scenario, most of people in this world own a car and most common problem that being faced by them is flat tyres. When this problem occurs usually a person

took a very long time to change the flat tyres. This is because the process of changing the tyres must be done one by one. In the past, this process was done manually which required a lot of energy to do it and due to the long period in changing the car tyres, it will lead to back problems. This is because a person needs to bend their body every time to loosen or tighten the lug nuts.

As the time flies, the technology have introduced pneumatic impact wrench which using compressed air as the common source of power and also cordless impact wrench which using battery as the power source. Both of the tools have speeds up the process of the tyres changing and users manage to save a lot of time in this process.

Although both tools manage to speed up the process, but still a person will face with the back problems. This is due to the person need to bend their body to loosen or tighten the lug nuts one by one until all the lug nut of the tyres loosen or tighten. So to overcome this problem, I have proposed to create a multi spindle impact wrench where this tool may be able to be used to loosen or tighten all the lug nuts of the car tyre simultaneously at the same time. This idea will be able to save a lot of a time, energy, cost and also manage to help and ease the work of the user which have the back problem.

1.3 Objectives

The aim of the project is to develop a multi-spindle impact wrench that able to remove all the lug nut of the car tyre at the same time. There are several objectives that have been developed for the project:

- 1) To develop a mechanism of a multi-spindle impact wrench.
- 2) To analyse the structure of the multi-spindle impact wrench.
- 3) To construct a working model of the multi-spindle impact wrench.

1.4 Significance of project

The significance of this project are listed below:

- The multi-spindle impact wrench will have a capability to overcome the problem in loosen or tighten lug nuts of car tyres.
- The multi-spindle impact wrench will have four (4) anvils in a device, so that the multi-spindle impact wrench will be able to unscrew all the lug nut simultaneously at the same time.
- The multi-spindle impact wrench will help to reduce the energy used, save more time and save cost.

1.5 Scope of Project

Scopes of project as listed below:

- To design mechanism and perform structural analysis of the multi-spindle impact wrench by using Solidworks.
- To create a simulation for the mechanism of the multi-spindle impact wrench by using the Solidworks.
- To construct a prototype of the multi-spindle impact wrench.

1.6 Outline of the Thesis

This report is organized systematically to portray the development stages that concluded the whole project. This report is divided into two stages. For the first stage, it includes Chapter 1, 2 and 3. While for the second stages it will covers Chapter 4 and 5 which will be completed in Semester 2.

Chapter 1 describes a brief introduction of the projects, the purpose and aim of the project, the description of the approach to the problem and a brief outline of the structure of the following chapter.

Chapter 2 is about the literature review. In the literature review, it will explain more about the work of the literature in relation to the project research are to be review and analyse. This will be included the type of the impact wrench, hammer drill mechanism, hammering mechanism of the impact wrench, gearing system, bolt pattern and many more.

Chapter 3 is the methodology. It will describe the method that is being used to complete the projects from many sources such as book, references, interviews, internet, journals and articles. The method of designing and structure analysis of the multi-spindle impact wrench mechanism by using Solidworks software also will be discussed in this chapter.

In Chapter 4, the results analysis and discussion of the research are presented. All the data and calculation of the gearing system of the multi-spindle impact wrench also will be shown in this chapter.

Finally, Chapter 5 consists of the overall conclusion of the project discussing about the objectives and aim of the project and also some suggestion on how to improve this project in the future.

All appendices are included at the end of the report, following the list of references.

CHAPTER 2

LITERATURE REVIEW

2.0 Introduction

This chapter will briefly explain about the project research and also some theories that involved in order to complete this project. This chapter will include the explanation of the mechanisms involving in this project such as hammer drill mechanism, hammering mechanism and also the gearing system. Besides, this project also explaining about the type of impact wrench that available in the market, the difference between the brushed and the brushless DC motor, torque and also explaining about the bolt pattern.

2.1 Type of impact wrench

This subtopic will explain the various type of impact wrench based on the power source. Different type of impact wrenches has their own advantages and disadvantages. There are several types of impact wrenches that available in the market.

2.1.1 Air Impact Wrenches

The main power source of this impact wrench is compressed air that possibly the best power-to-weight ratio with a simple and low cost design. (Type Of Impact Wrenches And Their Uses, n.d.) High quality air wrenches feature a flow regulator into their design as part of the reversing valve or as a separate control to limit torque in either direction.

Furthermore, this impact wrench is smaller in size, lightweight and easy to use as they cause less fatigue. This impact wrench also come in a variety of drive sizes. Generally, the higher the drive size of an impact wrench, it can produce the large amount of torque. (Different Types of Impact Wrenches, 2014) Besides, the air impact wrench is more powerful than the other impact wrench since it can produce more torque.

The air impact wrench also is a durable tool and has a low maintenance appliance. For example, in situations when there is no power, the air impact wrenches still can be used constantly because it only used compressed air to operate. While the disadvantage of this impact wrench is the difficulty to adjust the power. Usually, it does not have a power adjustment mechanism. For examples in a situation that only needed only a little torque to operate, then the air impact wrench may produce excessive power which can end up breaking, shattering or damaging the bolts.



Figure 1: An air impact wrench (Different Types of Impact Wrenches, 2014)

2.1.2 Corded-Electric Impact Wrenches

The main power source of this impact wrench is electrical power supply. It also manages to deliver similar torque same as the air impact wrench. But due to the use of electrical power supply, it may limit the movement of the user when using it because of the cable and also the need of the electricity. While for the shape of the tools, it typically has longer bodies compared to the air impact wrenches where an electric motor was added to the extra length of the tool that functions to produces torques.

The main advantage of corded electric impact wrenches is that it can be used always as long as there is a power supply. Besides, the amount of power can be regulated which makes it very useful in situations that require little torque. While the main disadvantage of the corded electric impact wrench is it is useless when there is no power source. Thus, it cannot be used in remote locations where there is no electricity.



Figure 2: A corded electric impact wrench (Kato, 2018)

2.1.3 Cordless-Electric Impact Wrenches

The main power source of this impact wrench is battery. Generally, the lithium-ion (Li-ion) or nickel-cadium (NiCad) types of batteries being used for this impact wrench. Besides, the batteries can range from 18 to 28 volts and can be rechargeable depending on the model of the tools. (Different Types of Impact Wrenches, 2014) It also a compact, lightweight and powerful tool. The main advantage of the cordless electric impact wrench is portability and can be used virtually anywhere. This is because they do not require cables or separate air compressor to work, but they can still deliver enough torque to perform from light to moderate applications.

This type of impact wrench is very suitable to be used in emergency situation. For example, on-the-road repairs. This is because it is very convenience and flexibility especially in a situation where there is no source of electrical power available. While the main disadvantage of this tools are less powerful than corded or air impact wrenches. This is due to the batteries cannot store enough power to produce enough torque for more

powerful tasks. Furthermore, the power in the batteries also tends to run out faster which causes constant work interruptions to replace batteries. (Type Of Impact Wrenches And Their Uses, n.d.)



*Figure 3:*A cordless electric impact wrench (Motor Vehicle Maintenance & Repair, 2015)

2.1.4 Hydraulic Impact Wrenches

The hydraulic impact wrench uses water under pressure as a power source to deliver the torque that the machine uses to tighten or lose screws and nuts. (Type Of Impact Wrenches And Their Uses, n.d.) Furthermore, a hydraulic impact wrench is also lightweight but quieter than other impact wrenches and sometimes stronger and more accurate than air impact wrench. Plus, the hydraulic impact wrench is powerful where it manages to have similar torque output as same as air impact wrench and it also can be operated for long periods of time with the right power source. Besides, some hydraulic impact wrenches can be operated underwater. For extreme applications such as in manufacturing industries, building, construction and also other huge installations, this type of impact wrench is the most suitable and recommended tools to tighten or lose screws and nuts.



Figure 4:A hydraulic impact wrench

2.1.5 Manual Impact Wrench

Manual impact wrench features a head technology that capable of converting spring power in incredible sharp tensional blows. (Type Of Impact Wrenches And Their Uses, n.d.) Without the need of other power source such as electricity, batteries, hydraulics or air compressors, every impact blow is delivered enough torque directly to the fitted impact socket to lose a bolts and nuts. In term of power and time, the manual impact wrench is low powerful but it is more portability, safety, affordability, and durability.

2.2 Hammer drill mechanism

Hammer drills is using a rotating power with the help of vibration to pulverize the hard material into the surface. Moreover, sometimes the hammer drill's bit at the surface of material gets extremely hot, so the tip is made out of carbide steel to resist the heat. The mechanism includes firstly an impact platform within the housing where the impact platform is in connection with the drill bit for receiving and transferring the impact forces to the drill bit. (United States of America Patent No. US 7,137,458 B2, 2006)