UNIVERSITI TEKNIKAL MALAYSIA MELAKA

Design Improvement of Wheel Spacer

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By

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DESIGN IMPROVEMENT OF WHEEL SPACER

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ABSTRACT

This project focused on the problems of existing wheel spacer design thus developing new designs to eliminate these problems. Based on the scoring concept wheel spacer with the slotting design was chosen as the new design. Document control of wheel spacer was developed with the proper fabrication flow chart, production tooling and computer drawing. Special fixture of milling machine was developed to match the wheel spacer with slotting design. Problems and observation of the wheel spacer fabrication were among the matters discussed in this report. Comparisons were made for both the new and existing design of wheel spacer. From the machine design calculation, the clamping force and tensile stress area for the wheel spacer were 0.0055 $inch^2$ and 10170 lb. Finally the destructive testing of new design was done to ensure the existing problems were eliminated.

ABSTRAK

Projek ini memfokuskan masalah pada rekabentuk Pelapis Roda yang ada di pasaran dan rekabentuk baru dipertingkatkan untuk menyelesaikan masalah ini. Berdasarkan konsep skoring, rekabentuk slot dipilih sebagai rekabentuk yang baru. Dokumen kawalan dibangunkan dengan arus pembuatan, peralatan dan lukisan kejuruteraan roda pelapis. Rekabentuk lama dibandingkan yang baru dan dinilai hasilnya. Daripada, mesin rekabentuk pengiraan, daya pengapit dan daya tegangan permukaan ialah 0.0055 $inch^2$ dan 10170 paun. Akhir sekali, percubaan musnah dilakukan bagi memastikan masalah rekabentuk lama diselesaikan.

DEDICATION

To my beloved family and friends

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A debt of gratitude to my talented supervisor, Mr. Taufik for his high dedication, advises and superb guidance, which prepared me in overcoming the challenges in this final year project. I would also like to thank take this opportunity to thank to all those have been involved in making this project a successes. And finally, a warm thanks to the technician in D.Cam Automotive Accessories for his helping hand to fabricate the wheel spacer.

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LIST OF ABBREVIATIONS, SYMBOLS, SPECIALIZED NOMENCLATURE

CNC	–	Computer Numerical Computer
G-Code	–	Programming language
HSS	–	High speed Steel
Ib.in	–	Pound per inch
M	–	Major Diameter for thread
MM/MIN	–	Millimeter per minute
P	-	Pitch
PCD	–	Pitch Circle Diameter
PLC	–	Programmable Logic Controller
R_a	–	Surface roughness
Rev /min	–	Revolution per minute
T6	–	Heat Treated
TiN	–	Titanium Nitride

CHAPTER 1
INTRODUCTION

1.1 Background

According to Alloy Spacer Germany (2007), Wheel spacers move the wheel out from the hub, effectively widening the stance of the vehicle and lowering its roll centre. This simple modification increases lateral stability, which in turn provides improved handling, greater safety and of course, the sleek style you've been looking for. Depending on vehicle make and model they are available for most domestic and imported automobiles.

Wheel spacers are also used when a cars such as: Nissan 240SX, 350Z / GTO, Peugeot 406's or some Alfa Romeo's (to name a few) have upgraded brakes, and want to fit aftermarket alloy wheels on, but the larger brake calipers prevents this by coming into contact with the alloy wheel. Other customers needs wheel spacers when they have used brake upgrade kits such as Brembo, Stop-Tech, Endless and other brake kits. Consumers need Professional knowledgeable company when purchasing alloy wheel spacers.

1.2 Problem Statement

There are different types sport wheel available in the market. But the original wheel hub cannot fit with the sport wheel. So the spacer wheel is manufactured to move the wheel out from the hub, effectively widening the stance of the vehicle and lowering its roll centre. Besides that, the wheel stud used to tighten the wheel spacer and sport wheel is easily getting loose when over force is applied on the wheel stud. As a result, the wheel stud cannot clamp the sport wheel effectively.

1.3 Objective

1) To improve existing design of the wheel spacer.

2) To fabricate and assembly of new design automotive wheel spacer.

3) To analyze automotive wheel spacer.

1.4 Scope of the Project

Propose a new design of wheel spacer which prevents screw of wheel spacer from easily getting loose. Describe and fabricate new design of spacer wheel with and Lathe machine and Computer Numerical Control (CNC) Milling. Destructive testing will be performed in this project. Besides that, the basic analysis of wheel spacer such as Clamping force and tensile stress area are included in this project. All this values are approximated.

1.5 Schematic of Project

Chapter 1 describes about the background of the study, project problem statement, and the objective and scope of the project.

Chapter 2 highlights some literature reviews related to the study, which includes descriptions on Design Wheel Spacer, Manufacturing Process of wheel spacer and Fastener to clamp the wheel spacer. Besides that, it describes the Concept Scoring for product design and development.

Chapter 3 shows the methodology of the Wheel Spacer project in details. This chapter explains how to develop the wheel spacer with generic product development process. This chapter also includes limitations of the project.

Chapter 4 shows details design such as computer drawing, production tooling, process plan for fabrication and assembly. It also shows existing design and new design of the wheel spacer.

Chapter 5 provides explanation on the design requirements for the wheel spacer. Besides that, this chapter also illustrates the concept scoring for the wheel spacer which determines the final of choice design to fabricate. Moreover, some analysis of the clamping force and tensile area of thread of wheel spacer are calculated.

Chapter 6 makes a conclusion on the project where the best designs were chosen. Recommendations are included in this chapter as well.

CHAPTER 2
LITERATURE REVIEW

2.1 Introduction

Chapter 2 described overall of the wheel spacer which include wheel stud, material, design and manufacturing method to process wheel spacer. Besides that, it also theory shows machine design calculation for clamping force and tensile area for bolts and nut.

2.2 Wheel Spacer

From the clarification explanation of Wikipedia(2008), Wheel studs are the bolts that the wheel of an automobile rest on. Lug nuts are fastened to the wheel stud to secure the wheel. Wheel studs can be either factory equipment or aftermarket add-ons. They are semi-permanently mounted directly to the vehicle brake drum or disk hub.

The primary advantage of wheel studs over wheel bolts is greater strength due to an increase in clamping force and resistance to loosening. Another benefit is greater ease for tire changes by creating the ability to lift both the wheel and tire onto the studs creating the ability to hold and locate the assembly during tire changes rather than trying to hold up the wheel and tire while lining up the holes to insert a bolt.

Wheel studs are replaceable and come in two basic kinds: press-in and screw-in. Welded-in studs are possible but unlikely to be encountered. Screw-in studs simply screw into the existing threaded bolt hole in the hub. The end that screws into the hub is usually either threaded with a higher tolerance fit or installed with a chemical thread locking compound to keep it from backing out from the hub when the lug nut is removed

Press-in studs are installed from the back side of the disk or drum hub and require removal of the hub from the vehicle for installation or removal. They consist of a threaded portion and a larger diameter section that is splined to prevent rotation. The diameter of the splined section is larger than the hole in the hub requiring a press fit to seat the stud. The stud is prevented from being pulled through the hub by a larger diameter stop on the end.

Most press-in studs are designed and recommended to be installed with a mechanical or hydraulic press to ensure proper seating without damage. It is possible, though not advised, to install a press-in by using a washer and nut to "draw" it into the hub. In doing so, the installer must ensure that the stud is fully seated and that no damage is done to the threaded portion of the stud.

2.3 Manufacturing Process

2.3.1 Lathe Operation

From the explanation of Wikipedia (2008), turning is process in machine tool which spins a block of material so that when abrasive, cutting, or deformation tools are applied to the workpiece, it can be shaped to produce an object which has rotational symmetry about an axis of rotation, called Solids of Revolution. Examples of objects that can be produced on a lathe include candlestick holders, table legs, bowls, baseball bats, crankshafts or camshafts.

The material may be held in place by a chuck or worked between one or two centers of which at least one can be moved horizontally to accommodate varying material lengths. In a metalworking lathe, metal is removed from the workpiece using a hardened cutting tool which is usually fixed to a solid moveable mounting called the "toolpost", this arrangement is then moved around the workpiece using handwheels and/or computer controlled motors. The main difference between the Milling Machine and the Lathe is that in the Milling Machine the tool is moving but in the Lathe, the work is moving. Modern CNC lathes can do secondary operations like milling in X,Y,Z direction by using driven tools also called live tools. When driven tools are used the work piece stops rotating and the driven tool executes the machining operation with a rotating cutting tool. Driven tools increase machining performance as all operations can be made in one set up in the CNC lathe

2.3.2 Milling Operation

From the explanation of Wikipedia(2008), Milling is the complex shaping of metal (or possibly other materials) parts, by removing unneeded material to form the final shape. It is generally done on a milling machine, a power-driven machine that in its basic form is comprised of a milling cutter that rotates about the spindle axis (like a drill), and a worktable that can move in multiple directions (usually three dimensions [x,y,z axis] relative to the workpiece, whereas a drill can only move in one dimension [z axis] while cutting). The motion across the surface of the workpiece is usually accomplished by moving the table on which the workpiece is mounted, in the x and y directions. Milling machines may be operated manually or under computer numerical control (CNC), and can perform a vast number of complex operations, such as slot cutting, planing, drilling and threading, rabbeting, routing, etc. Two common types of millers are the horizontal miller and vertical miller.

2.3.4 Drilling Operation

From the explanation of Wikipedia (2008), Drilling is the process of using a drill bit in a drill to produce holes. Under normal usage, swarf is carried up and away from the tip of the drill bit by the fluting. The continued production of chips from the cutting edges pushes the older chips outwards from the hole. This continues until the chips pack too tightly, either because of deeper than normal holes or insufficient backing off (removing the drill slightly [breaking the chip] or totally from the hole [clearing the bit] while drilling). Lubricants (or coolants) (i.e. cutting fluid) are sometimes used to ease this problem and to prolong the tool's life by cooling, lubricating the tip and improving chip flow.

Taps and dies are tools commonly used for the cutting of screw threads in metal parts. A tap is used to cut a female thread on the inside surface of a predrilled hole, while a die cuts a male thread on a preformed cylindrical rod.

2.4 Fastener

2.4.1 Thread Designations

According to Mott (1999), the formula for tensile stress area is

$$A_t = (0.7854)\ (D\text{-}0.974\ 2p)$$

2.4.2 Performance of Bolted Joints

Besides that, Mott (1999) also provide the Tightening Torque formula

T =KDP

Where T = torque, Ib.in

D = Nominal Diameter of threads, in

P = Clamping load, Ib

K = Constant Dependent on the lubrication present, where K =0.15 and K =2.0 if the threads cleaned and dried