



**KOLEJ UNIVERSITI TEKNIKAL KEBANGSAAN MALAYSIA**

**DESIGN AND FABRICATION OF PRESSURE  
LIMITING VALVE FOR AUTOMOBILE  
TUBES/TUBELESS**

Thesis submitted in accordance with the requirements of the  
National technical University college of Malaysia for the Degree of  
Bachelor of Manufacturing Engineering (Honours) (Manufacturing Process)

By

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May 2006



## KOLEJ UNIVERSITI TEKNIKAL KEBANGSAAN MALAYSIA

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JUDUL: DESIGN AND FABRICATION OF PRESSURE LIMITTING VALVE FOR AUTOMOBILE TUBES/TUBELESS

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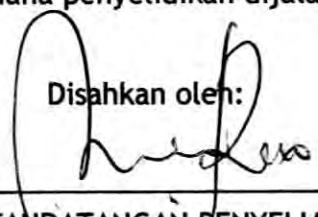
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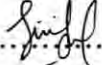
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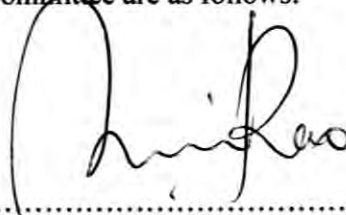
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## **APPROVAL**

This thesis submitted to the senate of KUTKM and has been accepted as fulfillment of the requirement for the Degree of Bachelor of Manufacturing Engineering (Honours) (Manufacturing Process). The members of the supervisory committee are as follows:



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## **ABSTRACT**

Pressure limiting valve for automobile tube/tubeless is a new design where its functions are to stable and maintain air pressure in tube tire. This valve operates on very simple principle. It has the functions and operations as the pressure relief valve or safety valve. It was based on a selection of high pressure springs that are manufactured to specific tolerance. It used suitable pressure range to match most common pressure settings for cars, motorcycles, commercial vehicles, trailers and caravans. Pressures were released to atmosphere through relief port using spring compression when tyres are over inflated cause pressure or temperature exceeds preset limits. This system is both reliable and affordable of a potentially dangerous reduction in tyre pressure.

## **ABSTRAK**

Injap kawalan tekanan untuk tiub kenderaan merupakan satu rekabentuk baru di mana ia boleh menstabilkan kemasukan tekanan udara di dalam tiub tayar. Fungsi injap ini cukup mudah di mana ia berteraskan konsep injap pelega yang sedia ada. Spring merupakan komponen utama di dalam fungsi injap ini. Ia dapat menghadkan tekanan di dalam tayar dengan sesuai pada kenderaan. Tekanan berlebihan akan dilepaskan ke udara melalui lubang keluar. Sistem ini mampu untuk mengurangkan tekanan yang berlebihan di dalam tiub tayar.

## **DEDICATION**

*Specially dedicated to my beloved father, Sahak Bin Gani and my mother, Sariah Bt. Hamid who were very concern, understanding supporting. Thank you for everything to my supervisor, P.S.Sivarao, my partner, Mohd Fairuz Bin Mohd Rashid, my sisters, brother and all my friends. The work and success will never be achieved without all of you.*

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# LIST OF ABBREVIATIONS, SYMBOLS, SPECIALIZED NOMENCLATURE

PSI	- Pound force per square inch
ASTM	- American Standard Testing Machine
N/mm <sup>2</sup>	- Newton's per millimeter square
Kp/m <sup>2</sup>	- Kilopascals per meter square
Atm	- Atmosfera
<i>W</i>	- Weight flow of gas that valve is relieving (Ib/hr)
<i>K</i>	- Flow coefficient for gas [see UG-131(d) and (e)] <sup>6</sup>
<i>A</i>	- Actual discharge flow area of the safety valve or orifice (sqin)
<i>P</i>	- (set pressure X 1.1 plus atmospheric pressure*) (psia)
<i>M</i>	- Molecular weight
<i>T</i>	- Absolute temperature at inlet (°F + 460)
<i>C</i>	- Constant for gas or vapor which is a function of ratio of specific heat,
<i>F<sub>s</sub></i>	- Force at solid length,
<i>L<sub>s</sub></i>	- The maximum force that the spring ever sees.
<i>F<sub>o</sub></i>	- Force at operating length,
<i>L<sub>o</sub></i>	- The maximum force the spring sees in normal operation.
<i>F<sub>i</sub></i>	- Force at installed length,
<i>L<sub>i</sub></i>	- The force varies between <i>F<sub>o</sub></i> and <i>F<sub>i</sub></i> for a reciprocating spring.
<i>F<sub>f</sub></i>	- Force at free length,
<i>L<sub>f</sub></i>	- This force is zero.
KM/H	- Kilometer per hour
MPH	- Mile per hour
KG	- Kilogram
PTFE	- Polytetrafluoroethylene



# CHAPTER 1

## INTRODUCTION

### 1.1 Introduction

Pressure limiting valve is one component that same functions with pressure relief valve or safety valve. It used to prevent the gas pressure exceeding the working limit, thus eliminating possible equipment tyre damage. The main function for this design is compression coil spring. It used to control the supply of air or gas to pressure sensitive applications and prevent an over-pressure occurring in this valve. This coil spring will be setting their operation deflection suit with its applications.

When the pressure over the setting compressed spring, it automatically presses out through the relief hole which air sound were heard. This is basic function for this design which will be improving to suppress instabilities that shorten operational lifetimes and create hazards in the operation of pressure limiting valve. The valve is developing to control the input pressure in the tube tyre.

## **1.2 Background of the project**

Under inflation tyre was most common cause of failures in any kind of tyre and may result in cracking, component separation or "blowout," with unexpected loss of vehicle control and accident. Under inflation also increases sidewall flexing and rolling resistance resulting in heat and mechanical damage.

Pressure limiting valve fully made from aluminium alloy material. It used spring system to limit pressure in tube tyre. This spring was compressed and extended the shaft when pressure applied. Over pressure were releases to atmospheric throughout relief port. For this valve, it has 2 input system pressures either from tube tyre or pressure pump. When input or output pressure over spring compression range, automatically pressure throughout from the relief system.

## **1.3 Problem statement**

Mostly, vehicle users don't know the suitable pressure when fill in tube tyre. Lower or over pressure can make tyre damage and inflation. Besides that, vehicle users confused the pressure value in tube tyre when carrying extra weight. The pressure was filling in tube tyre until looked hardened. So the tyre can get under or over inflation. Under-inflation of tyres causes overheating, which weakens the road-holding of tyres. It also causes irregular wear and the tyre could break apart due to internal damage. But over-inflation was just as dangerous, as any impact damage could cause the tyre to burst.

Many new or replaced tyres are damaged due to inflation lost within the first few days after bad fitment or leaking valves. Vehicle users usually check tyres every day especially for the first week, and thereafter on a weekly basis. It is highly recommended that each driver has his own pressure gauge to be able to check pressures regularly and inflate tyres whenever necessary to avoid damage and/or uneven wear due to incorrect pressures. By checking pressures regularly they ensure that get use of the full life of the tyre. Using this limiting valve, it can maintain the suitable pressure when users fill into tube tyre which can improved period lifetime of tyre and avoid from inflation.

#### **1.4 Objectives**

In tube tyre, proper inflation pressure is necessary for optimum tyre performance, safety and best fuel economy. To maintain proper inflation pressure, frequently check tyres with an accurate tyre pressure gauge. Higher inflation pressure increases stiffness which may deteriorate ride and generate unwanted vibration.

So, the objectives for this project are:-

- To limit the tyre pressure without caring the pressure set at the pressure supply.
- To test the exceeding of pressure in the tyre (by release to atmosphere).

## 1.5 Scope of project

For this project, it was very important to prevent scope of project which prevent the problem in do this project. They are:-

- To analyze capability of valve which able to flow out an excessive pressure (if happen) exit from tube tyre.
- Input pressure can be pre-set although output pressure value from pressure gauge is setting different.
- In beginning, the valve is analyzed in static condition before go to dynamic condition.

## CHAPTER 2

### LITERATURE REVIEW

#### 2.1 Definition of tyre

Tyre was a roughly radial piece of rubber placed on a wheel to cushion it. Tyres generally have reinforcing threads in them; based on the orientation of the threads, they were classified as bias-ply/cross ply or radial. Tyres with radial yarns (known as radial tyres) were standard for almost all modern automobiles.

Air-filled tyres were known as pneumatic tyres, and these are the type in almost universal use today. The air compresses as the wheel goes over a bump and acts as a shock absorber. Tyres were inflated through a Schrader valve. Attempts have been made to make various types of solid tyre but none has so far met with much success. The "steering feel" of such tyres was different from that of pneumatic tyres, as their solidity does not allowed the amount of torsion that exists in the carcass of a pneumatic tyre under steering forces, and the resultant sensory feedback through the steering apparatus.

Some air-filled tyres, especially those used with spoke wheels such as on bicycles, or on vehicles traveling on rough roads, have an inner tube. This was a fully sealed rubber tube with a valve to control flow of air in and out. Others, including modern radial tyres, use a seal between the metal wheel and the tyre to maintain the internal air pressure (*tubeless tire*). (Houghton Mifflin, 2001)

### 2.1.1 Inflated tyres

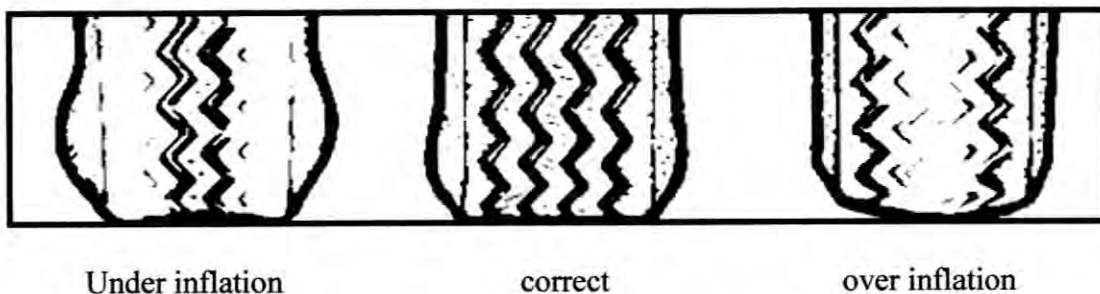


Figure 2.0: Inflation tyre (Dunloptires, 2003)

Under-inflation can cause many tyre-related problems. Because a tyre's load capacity was largely determined by its inflation pressure, under-inflation results in an overloaded tyre. An under-inflated tyre operates at high deflection, resulting in decreased fuel economy, sluggish handling and may result in excessive mechanical flexing and heat buildup leading to catastrophic tyre failure. Figure 2.0 shows the inflation tyre when it under inflation, correct and over inflation.

Correct inflation was especially significant to the endurance and performance of radial performance tyres. For example, because of a performance radial's aspect ratio and design, it may not be possible to look at a radial tyre and actually see under-inflation of 5 psi. However, under-inflation of 5 psi can reduce a performance tyre's tread life by 25%. A typical tyre may also lose 1 to 2 psi a month, if not checked and adjusted.

Temperature Effects: Air pressure was affected by temperature. The air under pressure in a tyre is no exception. Typically, an inflation pressure can change by 1 psi for every 10 degrees Fahrenheit of temperature change. Higher temperature means increased pressure.

### **2.1.2 Maintain proper inflation pressure in tires.**

Proper inflation pressure was necessary for optimum tyre performance, safety and best fuel economy. To maintain proper inflation pressure, frequently check tyres (when they are cool) with an accurate tyre pressure gauge. For example, it was difficult to tell just by looking at radial tyres whether they are under inflated. Evidence of air loss or repeated under inflation requires tyre removal and expert inspection. Higher inflation pressure increases stiffness which may deteriorate ride and generate unwanted vibration.

Tyre footprint and traction were reduced when van, pickup or RV tyres are over inflated for the loads carried. In particular, tires with aggressive tread patterns may contribute to oversteer or "roadwalk" if inflated beyond the inflation pressure specified in the Owner's Manual and vehicle placard for standard or customary loads. Over inflation also increases the chances of bruise damage. (Cybersteering, 2005)

Under inflation was the most common cause of failures in any kind of tyre and may result in severe cracking, component separation or "blowout," with unexpected loss of vehicle control and accident. Under inflation can increase sidewall flexing and rolling resistance resulting in heat and mechanical damage. Furthermore, when operating a vehicle equipped with radial tyres, it was difficult to notice when a tyre has gone flat or near flat since the "feel" of the vehicle does not change significantly.

A tyre was a pneumatic system, which supports a vehicle's load. It does this by using a compressed gas (usually air) inside to create tension in the carcass plies. It was important to realize that a tyre carcass has a high-tension strength, but has little or no compression strength. It was the air pressure that creates tension in the carcass and allows the tyre to function as a load-carrying device. That's why inflation was so important. In an inflated, but unloaded tyre, the cords pull equally on the bead wire all around the tyre. When a tyre is loaded, the tension in the cords between the rim and the ground was balanced or relieved. The tension in other cords was not changed.

Therefore, the cords opposite the ground pull upwards on the bead. This was the mechanism that transmits the pressure from the ground to the rim. In addition, a tyre must transmit handling (acceleration, braking, cornering) to the road. Cornering forces were transmitted to the rim in a similar manner to load. Acceleration and braking forces rely on the friction between the rim and the bead. Inflation pressure also supplies the clamping force, which creates friction.

A tyre also acts as a spring between the rim and the road. This spring characteristic was very important to the vehicle's ride. Too high an inflation pressure causes the tyre to transmit shock loads to the suspension and reduces a tyre's ability to withstand road impacts. Too low an inflation pressure reduces a tyre's ability to support the vehicle's load and transmit cornering, braking and acceleration forces.

For safety and vehicle performance, Dunlop recommends that tyre inflation pressure be checked at least once each week and as often as possible when tyres were cold (ambient air temperature and if the vehicle has not been driven for several hours.) Repeat or excessive inflation loss (more than 2 psi); visible damage such as knots, bulges, punctures, cuts, cracks, irregular wear; experiencing impacts, vibration or pulling; all require removal, expert inspection of tyre and rim to determine reparability, or the need for replacement. Damaged tyres may fail suddenly or burst upon re-inflation, resulting in serious injury. (Dunloptires, 2003)