"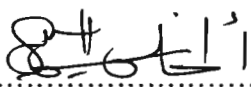I confess that have read this outstanding piece of works and from my view, it is acceptable in terms of scope and quality for the award of Bachelor of Mechanical Engineering (Thermal-Fluids)"

Signature   : ....

Supervisor's Name   : ENCIK AHMAD ANAS BIN YUSOF

Date   : 27 March 2008

Signature   : ....

Supervisor's Name   : ENCIK NAZRI BIN MD DAUD

Date   : 27 March 2008

A DEVELOPMENT OF A PORTABLE PNEUMATIC JACKING SYSTEM

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This report is submitted as partial requirement for the completion of the Bachelor of
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Fakulti of Mechanical Engineering
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March 2008

"I hereby declare that this project is written by me and it is my own effort and that no part has been plagiarised without citations."

Signature   : …………………………..

Name of Writer   : Samawi bin Ismail

Date   : 27 March 2008

To my beloved mother and father

And my family

ACKNOWLEDGEMENT

I wish to acknowledge a valuable advice and supports to my supervisor, En. Ahmad Anas bin Yusof for guiding and educating me along the path of conducting my Projek Sarjana Muda.

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v

ABSTRACT

Fluid power plays a crucial task in today's industry as this meadow deals with the generation, control and transmission of pressurised fluids. The development of a portable pneumatic jacking system is one portion of fluid power which applies air as a fluid medium and used for lifting the load around 1000 kg. The main objective of this project is to develop and produce a device which can help people to utilise it as a cylinder of jacking system. The investigation has been conducted by taking the advantages of air compared to liquid which clearly defined that air is light and not messy. Other than that, the studies have also been done by applying the relationships between the force imposed to the cylinder, the working pressure of compressed air and the size of the tube. The project done was based on several methodologies which were the design concept, materials used, assembling processes, bill of materials and last but not least the analysis and calculation. After the completion of producing the product, some field tests have been conducted which were on the human weigh, on the pneumatic table and on the Kancil car; the maximum operating pressure of 3.4474 bars could be used to lift the weigh of 255.9156 kg with no stroke measured. By comparing the analyses made with the results obtained, it is clearly seen that the use of 3.4474 bars pressure could only be used to lift the weigh below than 255.9156 kg. Therefore, the tyres are not to be recommended to lift the weigh of car, otherwise the use of specialised material such as air lifting bag is suggested since the bag has been specialised for the use of high pressure.

ABSTRAK

Kuasa bendalir memainkan peranan yang besar dalam bidang industri dewasa ini kerana bidang ini melibatkan kuasa penjanaan, kawalan dan penghantaran yang mengaplikasikan bendalir bertekanan. Pembangunan sistem jek udara mudah alih adalah satu cabang dalam bidang kuasa bendalir yang menggunakan udara sebagai bendalir dan digunakan untuk tujuan mengangkat beban kira-kira 1000 kg. Objektif utama projek ini adalah untuk membangun dan menghasilkan satu alat yang mana boleh menolong para penguna untuk menggunakannya sebagai satu silinder bagi sistem jek. Penelitian telah pun dilakukan dengan mengambilkira kelebihan udara berbanding cecair yang mana secara jelasnya udara adalah ringan dan tidak mengotorkan. Selain daripada itu, kajian juga telah pun dijalankan dengan mengaplikasikan hubungan antara daya yang dikenakan ke atas silinder, tekanan bekerja udara termampat dan saiz tiub. Projek yang telah dilaksanakan ini adalah berdasarkan kepada beberapa kaedah seperti konsep rekabentuk, bahan-bahan yang digunakan, proses-proses penyambungan, bil bahan-bahan; menekankan jumlah kos keseluruhan bagi pelaksanaan projek dan akhir sekali analisis dan pengiraan. Setelah menyiapkan produk, beberapa ujikaji telah dilakukan seperti ujikaji ke atas berat manusia, ujikaji ke atas meja pneumatik dan ujikaji ke atas kereta Kancil. Dengan membandingkan analisis-analisis yang dibuat dengan keputusan yang didapati, ianya dapat dilihat secara jelas bahawa penggunaan tekanan sebanyak 3.4474 bar hanya dapat mengangkat beban di bawah 255.9156 kg. Dengan ini, penggunaan tayar sebagai elemen untuk mengangkat beban tidak disarankan tetapi digantikan dengan penggunaan bahan yang telah dikhaskan seperti *air lifting bag* kerana beg ini mampu beroperasi dengan tekanan yang tinggi.

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LIST OF FIGURE

LIST OF SYMBOLS

F	=	Force, N
P	=	Pressure, bar
d_o	=	Outer diameter, m
d_i	=	Inner diameter, m
π	=	Transcendental and irrational constant = 3.14159
W	=	Weigh, kg
FS	=	Factor of safety
g	=	Gravitational acceleration = 9.81 m/s^2
V	=	Volume, m^3
A	=	Cross sectional area, m^2
S	=	Stroke, m

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CHAPTER 1

INTRODUCTION

The development of portable pneumatic jacking system which is connected to an air compressor was personally proposed by the author as to possibly assist people in lifting object whose weighs around 1000 kg. The project was emphasised on the design, fabrication and the assembling processes of the pneumatic jacking system so that the proposed project could be utilised as expected. Also, the project was stressed on the aptitude of the proposed system with the recent systems.

The preparations taken by the author were based on the previous project, journals, research, readings and other exercises. This report is prepared by describing detail information and methodology suggested by the author as to clearly inform readers what the project is all about and how the project has been executed. At the second end of the report, the author has come up with the analyses as these compare the theoretical lesson investigated by the author with the practical results. Plus, the author has made a conclusion and a recommendation of the proposed project.

1.1 BACKGROUND

A portable pneumatic jacking system is a device used to assist users to lift object whose weighs around 1000 kg. It consists of two tyres, one pressure regulator, one gate valve, two straight connectors, one fitter, 8-mm tube, 6-mm tube and two

clippers. All of these materials are available in the market and they are easy to be obtained.

This device can be used to lift weigh which is not practically to be recommended for heavy load since the application of pneumatic jacking system utilises small pressure inside the jack and small area of the tube. However, the use of this jacking system surely functions and yet can be used to lift load.

People can easily use this jack by connecting the hose of air compressor to the pneumatic jacking system via a straight connector. Once the compressor has established its power, the compressor will draw in the atmosphere air and compress it to the certain pressurised air level. The compressed air will then supply through a gate valve and pressure regulator. The gate valve used here is for blocking the flow of air as the pressure has been set by pressure regulator for a certain set level. The air flows to the tyre tubes through 8-mm tube and 6-mm tube will escalate the tubes and once inflated, they displace the cover to move upwards. As a consequence, the object is gradually lifted.

1.2   PROBLEM STATEMENT

A device used to lift heavy load by applying pneumatic system is rarely heard since the application employing hydraulic system is practically used as hydraulic is known as a substance that have a definite volume independent of the shape of the container. The development of pneumatic jacking system exploits air as a fluid medium since air is numerous and can be pressurised to a maximum level which can do work.

Hydraulics is usually used in jacking system compared to pneumatics. By the way, there are several advantages by applying air as a fluid medium in jacking system. Air is normally known as a very light in weight and because of that, the supply hoses connected to the compression element are not heavy. Other than that,

because the working fluid is just air, it is not technically applied for returnable line for the working fluid and leaks of the working fluid tend not to be messy.

Due to the advantages of pneumatics, the author has come up with the idea by utilising air as a substance in jacking system and the result of the analysis will be investigated and studied if there is any failure of the jacking system.

1.3   OBJECTIVES OF THE PROJECT

The objectives of this project are:

(i)   To develop, design and fabricate a portable pneumatic jacking system;

(ii)   To execute assembling processes among the components;

(iii)   To perform field test of portable pneumatic jacking system;

(iv)   To analyse the effects of maximum pressure inside the tubes;

(v)   To involve the theoretical and practical investigation, design and detail of the portable pneumatic jacking system.

1.4   SCOPES OF THE PROJECT

The scopes of the project are to achieve the limitation of portable pneumatic jacking system which has:

(i)   The maximum working load of 1000 kg;

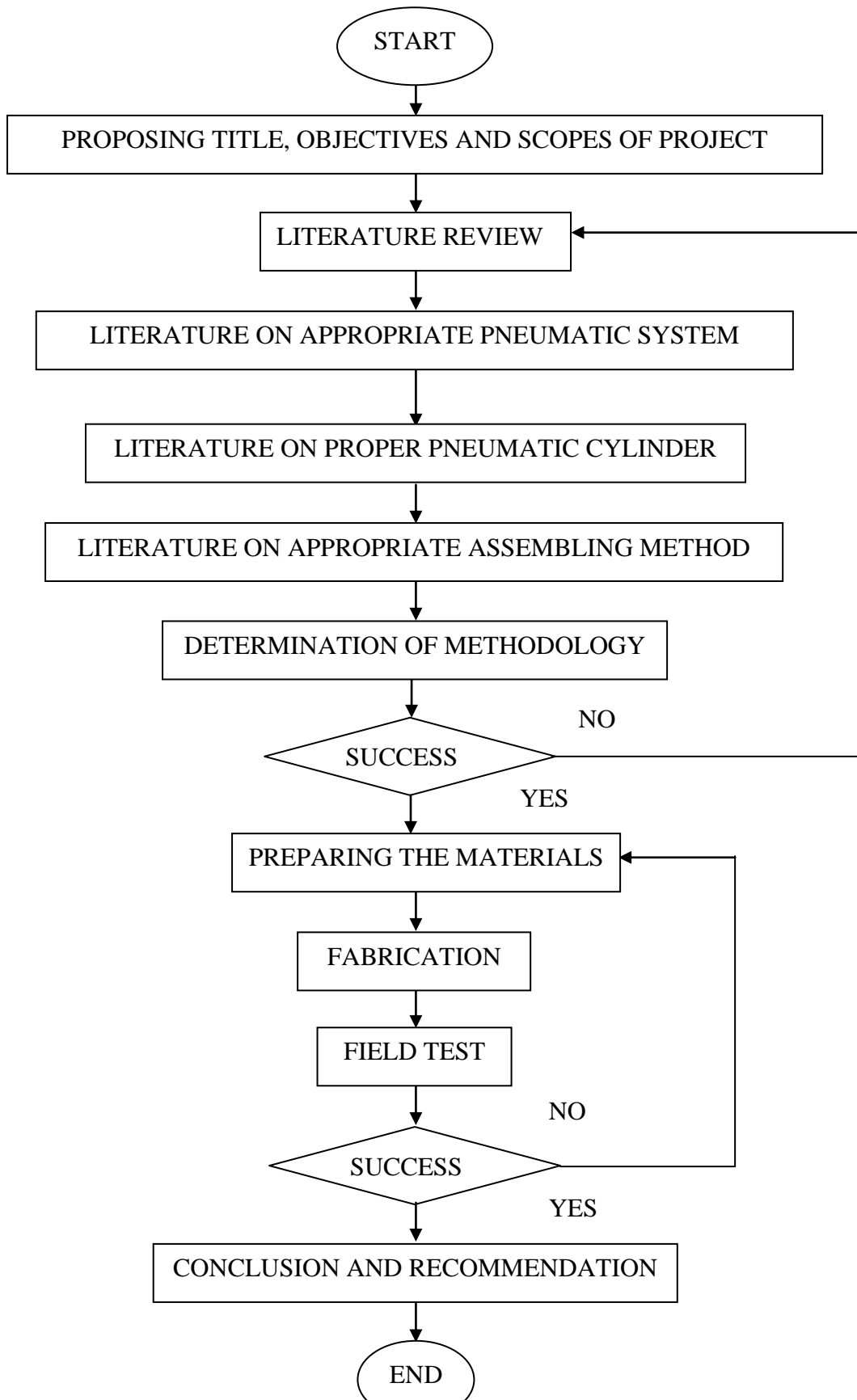(ii)   The maximum working pressure of 3.4474 bars.

1.5   EXPECTED OUTCOMES

During project researching, implementing and analysing, the expected outcomes are:

(i)   A portable pneumatic jacking system will achieve the author's target which is the design can be used to lift the 1000 kg car;

(ii)   The tyre tubes which are located inside the jacking system can withstand the weight of the car.

1.6   FLOWCHART OF PSM 1 AND 2 IMPLEMENTATION

Table 1.1: Flowchart of PSM 1 and 2 Implementation

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                        ┌─────────┐
                        │  START  │
                        └─────────┘
                             │
        ┌────────────────────▼────────────────────────┐
        │ PROPOSING TITLE, OBJECTIVES AND SCOPES OF    │
        │               PROJECT                        │
        └─────────────────────┬───────────────────────┘
                              │
              ┌───────────────▼────────────┐◄──────────────┐
              │     LITERATURE REVIEW      │               │
              └───────────────┬────────────┘               │
                              │                             │
        ┌─────────────────────▼──────────────────────┐     │
        │ LITERATURE ON APPROPRIATE PNEUMATIC SYSTEM  │     │
        └─────────────────────┬──────────────────────┘     │
                              │                             │
        ┌─────────────────────▼──────────────────────┐     │
        │ LITERATURE ON PROPER PNEUMATIC CYLINDER     │     │
        └─────────────────────┬──────────────────────┘     │
                              │                             │
        ┌─────────────────────▼──────────────────────┐     │
        │ LITERATURE ON APPROPRIATE ASSEMBLING METHOD │     │
        └─────────────────────┬──────────────────────┘     │
                              │                             │
        ┌─────────────────────▼──────────────────────┐     │
        │    DETERMINATION OF METHODOLOGY             │     │
        └─────────────────────┬──────────────────────┘     │
                              │            NO               │
                         ◇ SUCCESS ◇───────────────────────┘
                              │ YES
              ┌───────────────▼────────────┐◄──────────────┐
              │   PREPARING THE MATERIALS   │              │
              └───────────────┬────────────┘               │
                              │                             │
                    ┌─────────▼─────────┐                   │
                    │    FABRICATION    │                   │
                    └─────────┬─────────┘                   │
                              │                             │
                    ┌─────────▼─────────┐                   │
                    │    FIELD TEST     │                   │
                    └─────────┬─────────┘                   │
                              │            NO               │
                         ◇ SUCCESS ◇───────────────────────┘
                              │ YES
        ┌─────────────────────▼──────────────────────┐
        │    CONCLUSION AND RECOMMENDATION            │
        └─────────────────────┬──────────────────────┘
                              │
                        ┌─────▼─────┐
                        │    END    │
                        └───────────┘
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CHAPTER 2

LITERATURE REVIEW

2.1   INTRODUCTION

In the global world where transportations become surely essential for people, we are realised that automotive industry plays a big role to produce a transportation system such as cars, vans, motorcycles and others in order to ease people so that people can utilise those things in a practical manner. Realise that automotive industry grows rapidly, it is noticed that this field also plays a crucial task in producing additional parts or tool kit in order to assist people when they are facing a situation that cannot be predicted at the certain time.

One common device used in fluid power system can be referred to jack. As its name implies, jack is a verb and can be defined as accordance to WordNet homepage glossary as a device used to jack the car up so that people can change tyre and do maintenance works. Besides, jack is also referred to a device used to lift an object. Back in the early seventies century, jack named strand jacks were developed which are recognised as the most sophisticated lifting devices. The basis principle of strand jacks were originally from the Concrete Post Tensioning Principle which stated that the jack can be compared to a single-part winch. In a strand jack, a bundle of steel cables is guided through a hydraulic cylinder. [1]

2.2   FLUID POWER

Nowadays, fluid power is a vital technology among others which applies in general applications such as generation, control and transmission of power by using pressurised fluids. The term fluid refers to liquids or gases by means liquids are called hydraulics which use oil or water as a medium in hydraulics system whereby gases are defined as pneumatics which use air or other inert gases as a substance in pneumatics system.

Pneumatic or compressed air designates a gas mixture of the atmosphere of Earth which has been compressed for certain purposes. As its name implies, compressed air is defined as air that is condensed and contained at a pressure that is greater than the atmosphere. The process of air compression indicates that the mass of air that occupies a given volume of space reduces it into a smaller space and eventually produces greater pressure due to greater air mass. This also can be proved by referring to Blaise Pascal's words which state that *"Pressure exerted on a confined fluid is transmitted undiminished in all direction throughout the vessel or systems".* The basis principle which applies Pascal's law is illustrated in Figure 2.1. [2].

F1

F2

W1 = 1 pound

W2 = 10 pounds

A1 = 1 square inch
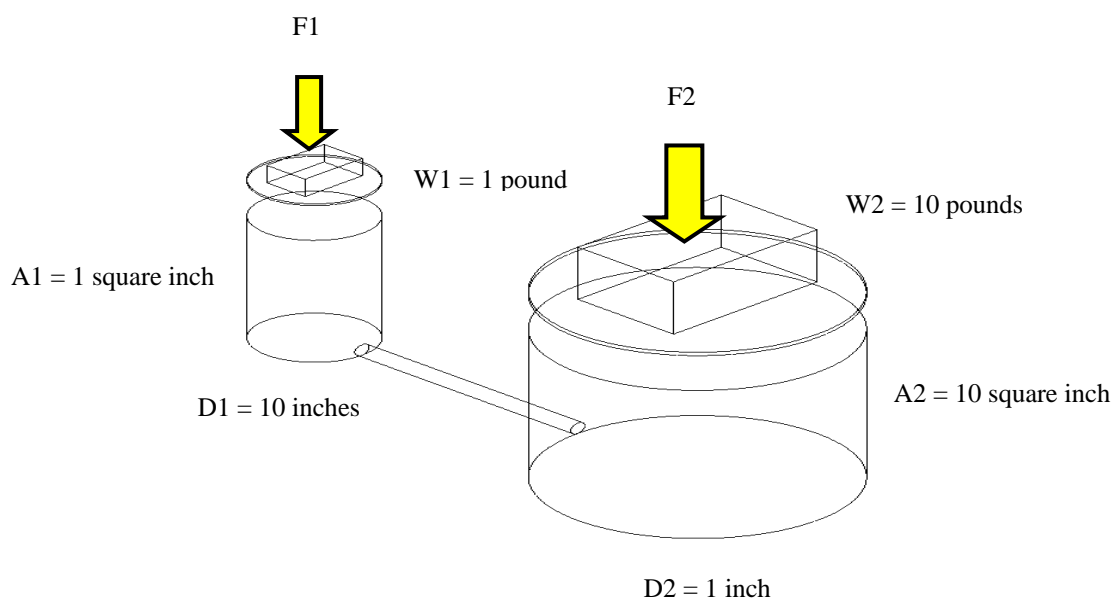
A2 = 10 square inch

D1 = 10 inches

D2 = 1 inch

Figure 2.1: Pascal's principle

Fluid power gives its own benefits to industry. One common advantage is that fluid power can transmit energy either in electrical or mechanical or fluid power or a combination of the three fields to acquire the most efficient in overall system. Fluid power also provide many advantages to users which include multiplication and variation of force in fractioning an amount of input forces into a big amount of output forces. Other than that, fluid power gives easy and accurate control by managing the large forces. [3]

2.3   RELATIONSHIPS BETWEEN PRESSURE, DIAMETER AND FORCE

The relationships between pressure, radius and force are defined as the force exerted on the cylinder which contains pressure of compressed air. Since the author has decided to use tubes, therefore the cross sectional area of tubes is less than the piston since tubes occupies a hollow shape at the middle.

The relationship between the force exerted, pressure and diameter of the tubes is as follows:

$$F = p \left(\frac{\pi d_o^{\,2}}{4} - \frac{\pi d_i^{\,2}}{4} \right)$$

Where:

   F represents the force exerted

   p represents the maximum operating pressure

   d_o represents the outer diameter of the tube

   d_i represents the inner diameter of the tube

The usage of the above equation is crucial in determining the force value since the author has come up with the initial and final calculation of load or weigh in the Chapter 3. [4]

2.4   JACKS IN MARKET

It can be seen that the usage of jacks is among a practical tool since jacks can be found at any hardware shops and offer variety of prices. Jacks in market ranges from small ones to bigger ones as this applies for many applications. Jacks can be sorted out into several groups such mechanical jacks, hydraulic jacks, air to hydraulic jacks and air lifting bags.

2.4.1   MECHANICAL JACKS

One typical jack used in industry is mechanical jacks. Mechanical jacks are used to lift heavy equipments whose weigh rated around 1.5 tons (1500 kg) or 3 tons (3000 kg). Mechanical jacks are categorised into their classification include ratchet jacks, screw jacks, super jacks, tank jacks, reel jacks, toe jacks, mine roof supports, push/pull jacks, trench braces and spreader and planer jacks.

Ratchet jacks are widely used in oil fields, shipyards, mining operations, construction, railroads and heavy-duty industrial maintenance. The jacks consist of double-lever sockets for jacking in close quarters, multiple-tooth pawls for strength and safety and adjustable spring links. The most practical of these jacks are 5-ton ratchet jacks that are all mechanically identical and vary in stroke and height. The use of 10-ton ratchet jacks is importability and is for lifting of 10 tons or less because of their low handle effort. Figure 2.2 shows the hatchet jacks. [5]