

**DESIGN AND FABRICATION OF PORTABLE BOOK RACK**

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## **ABSTRACT**

This project is about designing and fabricating the book rack that can store and keep the library equipment. It also has portability and easy to see from outside of the book rack. Another purposes this book rack give the user the easy to see inside the book rack with more directly. Numerous methods and process involve in this project for instance joining using welding process. The process to cut the sheet metal follows on their required dimension by using Turret Punch Machine. After all the process had been done, this Portable Book Rack project will help us to understand the fabrication and designing process that involved in this project.

## **ABSTRAK**

Projek ini mengenai merekabentuk dan mencipta tempat untuk menyimpan peralatan-peralatan perpustakaan yang mudah alih serta mudah dilihat dari luarnya. Tujuan lain rak buku mudah alih ini dibuat adalah untuk memberi kemudahan kepada pengguna untuk melihat apa yang terdapat dalam bekas peralatan itu dengan secara langsung/terus. Kebanyakan cara dan proses yang terlibat dalam proses penyambungan bagi projek ini adalah menggunakan proses kimpalan. Manakala proses untuk memotong kepingan besi mengikut ukuran yang dikehendaki adalah dengan menggunakan mesin Turret Punch. Setelah kesemua proses yang terlibat di dalam projek ini telah selesai, projek ini dapat membantu kita mengenal dan memahami setiap proses yang terlibat dalam pembuatan bekas peralatan ini.

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## **CHAPTER 1**

### **INTRODUCTION**

#### **1.1 Project Synopsis**

##### **1.1.1 General Project Synopsis**

The Fabrication of Portable Book Rack is done by using all necessary items and methods for instance sheet metal, skills in manufacturing process by perform MIG welding to joint the parts and etc. The advantages of the proposed book rack to be developed can be seen in its portable to be moved such that, people are offered to make their task easier since the book rack will facilitate them to put the items such as book, magazine and etc.

The process of development is initiated from designing the shape of the book rack by considering the function as well. In order to produce user friendly product that is suitable to the consumer, consideration to the ergonomic factor is taken into account. It involves the measurement process before the materials are cut into pieces before joined together.

The project involves small analysis of the Portable Book Rack chassis or frame body and fabrication of the book rack itself with concerns regarding strength, durability, ergonomic factor, dynamic resistance and convenience. New concept of book rack is required to improve its durability and functions.

## **1.2 Problem Statement**

This book rack will primarily can help people especially members of students to store the book after using it. The placement of book is not compatible because it located on table. After using the book student only compiles the book and so that, the arrangement of the book is not regulated and scattered. Thus, the development of this book rack is hope can provide better arrangement at the book by store it at on place.

## **1.3 Project Objectives**

This project is to make the book rack that has commonly in market normally is sheet metal and unportable to become portable and more functionality side. The book rack is combination of sheet metal, rectangular hollow steel and wheel. So the objectives of this project are:

- To design book rack that is suite to its application especially for loading items.
- To minimize the manufacturing cost by minimize the complexity of the book rack and simulate the material used with cheaper material but having high strength and endurance.
- To fabricate and introduce the new concepts and ideas for future prospect of book rack.

## **1.4 Project Scope of Work**

- **Literature Review:** Valuable data are searched and gathered. Considering the shape of the book rack in terms of its complexity and method to produce.
- **Sketching & Designing:** Sketching and designing using Solidwork software in creating the design of the book rack.
- **Fabrication:** Fabricate and produce the book rack by using all necessary manufacturing process such as welding, bending, punching, grinding, measuring, marking and painting.
- **Testing & Evaluation:** Simulate the mechanism of the book rack produce is in line with the expected function to be.

### 1.5 Gantt Chart

Scope	Week(s)															
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	
Literature Review																
Design & Measurement consideration																
Acquisition & Material preparation																
Methodology study																
Fabrication																
Evaluation & Improvement																
Report writing																
Presentation																

= Planning Progress  
 = Actual Progress

**Figure 1.1 : Gantt chart**

## **CHAPTER 2**

### **LITERATURE REVIEW**

#### **2.1 Introduction**

The book rack is a tool that allowed people to put in their items such as book, files and etc to other places. It's help man to do their work without having a problem due to the heavy loading. It's also helps to reduce pain in waist, back, hand and feet. No mater how light the loading is, people usually will suffocate a large pain in their body if lifting the items in many times. So, this is when the people rely upon a book rack that can do items transferring many times with just a little effort. From the statement above conclude that the book rack playing a major role as an items transferring mechanism for people without having a problem of doing that. A book rack also functioned as a helper to people to hold items orderly while transferring between rough lands.

## 2.2 Literature Review

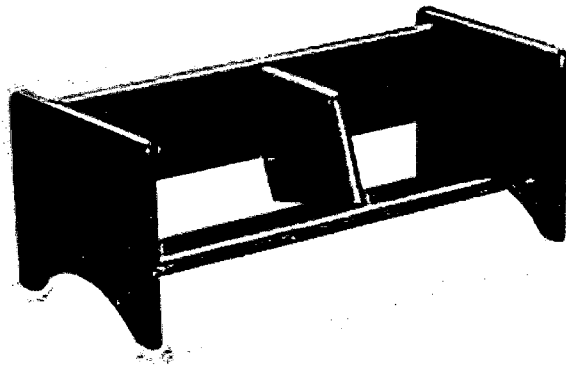
### 2.2.1 Book Rack Types and Descriptions

1. Buddy Products Two-Tier Recycled Steel Book Rack without Dividers Black -  
The Figure 2.1 shows that steel two-tier book rack without dividers. It's made from U.S.A of 30% recycled steel. The size of the structure textured steel is 30-1/8w x 10-1/2d. It can increase storage and save desk space. The bottom shelf opening is 12" high and the overall high is 20" high. The color of two-tier book rack is black. The advantages of this book rack are anti-rust properties and high stability because of large bottom surface area.



**Figure 2.1 : Buddy products two-tier recycled steel book rack without dividers black**

2. Carver Wood Products Wood Book Rack– The Figure 2.2 shows that it is the wood book rack. It's provides 16'' of book space. The slides of the bookend at the side convert rack to reading stand. The dimension of the book rack is 17w x 8d x 8h. Its have twin tray book shelf and also light weight. It's very suitable for small sized book.



**Figure 2.2 : Carver wood products wood book rack**

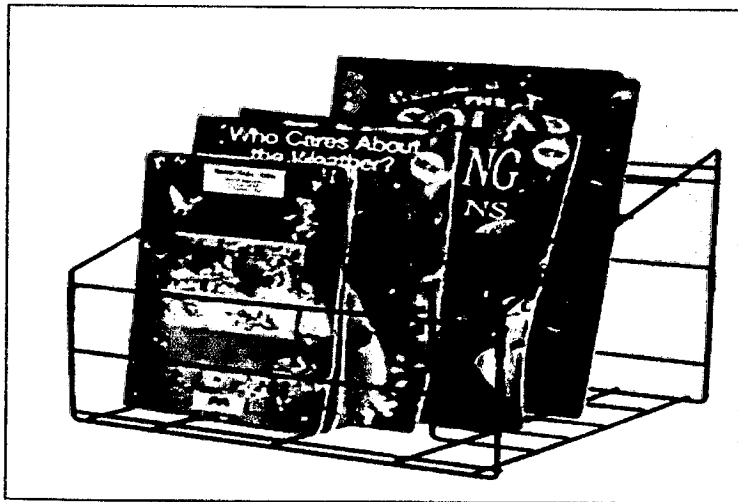
3. Contemporary Leaning Cappuccino Finish Wood Rack Shelf Bookcase– The Figure 2.3 shows that it's wood two-tier book rack without dividers. It's made from U.S.A. For extra information, it's a multiple compartments. That means, it can be easier to put more book into this book rack. This book rack also has stability to support their stand.





**Figure 2.3 :** Contemporary leaning cappuccino finish wood rack shelf bookcase

4. Big Book Rack BR10 - The Figure 2.4 shows that it's made from stainless steel. It is portable and light weight because the materials from a saving design. The advantages of this rack are attractive and anti rust



**Figure 2.4 :** Big book rack BR10

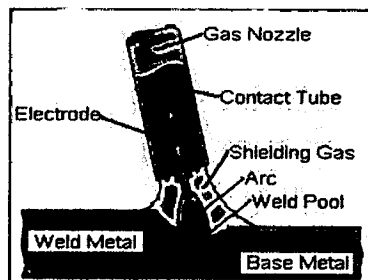
## 2.3 Basic Parts

- Wheel: Usually made from rubber that joined together with the bolt and nut with steel frame to ensure strength.
- Body: For outdoor use such as warehouse or workshop that requires full strength of body, wire frame or sheet metal body is used.

## 2.4 Method Joining of Welding Process

### 2.4.1 Basic Theory of Metal Inert Gas(MIG) Welding

This book rack will be joined by using the permanent joint which is welding process. The method joining that be able to fabricate and assembled the frame is Metal Inert Gas (MIG) Welding.



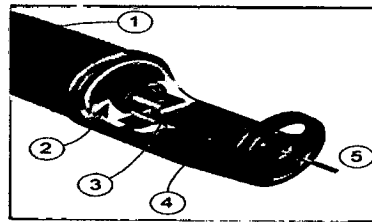
**Figure 2.5:** Basic structure of metal inert gas (MIG) Welding.

**Metal Inert Gas (MIG) Welding:** An arc is struck between a consumable electrode and the sheet metal to be welded. The consumable electrode is in the form of continuous filler metal. An inert gas surrounds the arc and shields it from the ambient to prevent oxidation. Carbon steels, low alloy steels, stainless steels, most aluminum alloys, zinc based copper alloys can be welded using this process.

Gas Metal Arc Welding (GMAW) is frequently referred to as MIG welding. MIG welding is a commonly used high deposition rate welding process. Wire is continuously fed from a spool. MIG welding is therefore referred to as a semiautomatic welding process. The shielding gas, forms the arc plasma, stabilizes the arc on the metal being welded, shields the arc and molten weld pool, and allows smooth transfer of metal from the weld wire to the molten weld pool. There are three primary metal transfer modes which are spray transfer, globular transfer and short circuiting transfer.[5]

#### 2.4.2 Welding Gun and Wire Feed Unit

The figure below show the basic structure on the nozzle of the MIG welding.



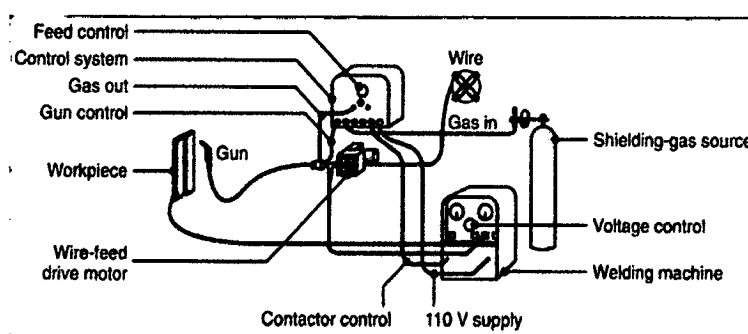
**Figure 2.6:** GMAW torch nozzle cutaway image. (1) Torch handle, (2) Molded phenolic dielectric (shown in white) and threaded metal nut insert (yellow), (3) Shielding gas nozzle, (4) Contact tip (5) Nozzle output fac.

### 2.4.3 Process of MIG Welding

In spray transfer, small, molten metal droplets from the electrode are transfer to the weld area at a rate of several hundred droplets per second. The transfer is spatter-free and very stable. High Direct Current (DC) and voltages and large-diameter electrodes are used with argon or argon-rich gas mixture used as the shielding gas. The average current required in this process can be reduced by using a pulsed arc, which superimposes high-amplitude pulses onto a low, steady current. The process can use in all welding positions.

In globular transfer, carbon-dioxide-rich gases are utilized, and globules are propelled by the forces of the electric-arc transfer of the metal, resulting in considerable spatter. High welding currents are used, making it possible for greater weld penetration and higher welding speed than are achieved in spray transfer. Heavier sections commonly are joined by this method.

In short circuiting, the metal is transferred in individual droplets (more than 50 per second), as the electrode tip touches the molten weld metal and short circuits. Low currents and voltages are utilized with carbon-dioxide-rich gases and electrodes made of small-diameter wire. The power required is about 2 kW



**Figure 2.7:** Basic equipment used in MIG operations

## **2.5 Method joining of Mechanical Fastening**

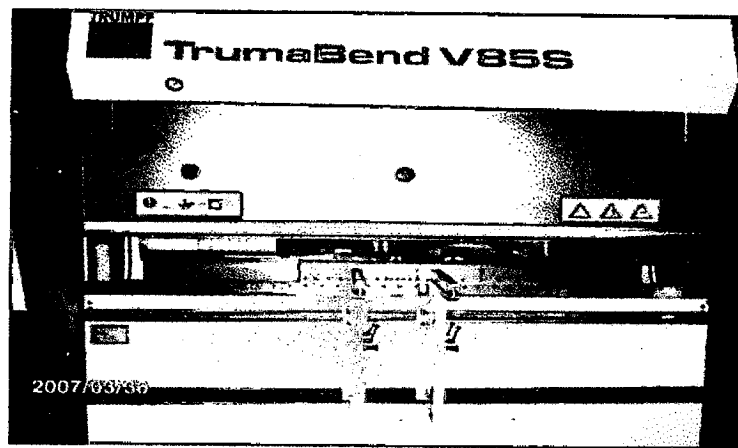
Two or more components may have to be joined or fastened in such a way that they can be taken apart sometime during the products service life or life cycle. Numerous products (including mechanical pencils, watches, computers, appliances, engines, and bicycle) have components that are fastened mechanically. Mechanical fastening may be preferred over other methods for the following reasons: ease of manufacturing, ease of assembly and transportation, ease of disassembly, maintenance, parts replacement, or repair, ease in creating designs that require moveable joints, such as hinges, sliding mechanism, and adjustable components and fixtures and lastly lower overall costs of manufacturing the product.

The most common method of mechanical fastening is by the use of bolts, nuts, screws, pins and a variety of other fasteners. These operations are known also as mechanical assembly. Mechanical fastening generally requires that the components have holes through which the fasteners are inserted. These joints may be subjected to both shear and tensile stresses and should be designed to resist these forces.[5]

## **2.6 Bending Process**

In engineering mechanics, bending (also known as flexure) characterizes the behavior of a structural element subjected to a lateral load. A structural element subjected to bending is known as a beam. A closet rod sagging under the weight beam is being compressed while the material at the bottom is being stretched. There are three notable internal forces caused by lateral loads shear parallel to the lateral loading, compression along the top of the beam, and tension along the bottom of the beam. These last two forces form a couple or moment as they are equal in magnitude and opposite in

direction. This bending moment produces the sagging deformation characteristic of compression members experiencing bending.[5]



**Figure 2.8: TrumaBend V85S Machine**

The compressive and tensile forces induce stresses on the beam. The maximum compressive stress is found at the uppermost edge of the beam while the maximum tensile stress is located at the lower edge of the beam. Since the stresses between these two opposing maxima vary linearly, there therefore exists a point on the linear path between them where there is no bending stress. The locus of these points is the neutral axis. Because of this area with no stress and the adjacent areas with low stress, using uniform cross section beams in bending is not a particularly efficient means of supporting a load as it does not use the full capacity of the beam until it is on the brink of collapse. TRUMABEND V85S - TRUMPF's CNC bending machine Figure 2.8 with 4 axes, is a high productive and very flexible machine. Technical data and their specifications are:

Model	: Trumpf
Type	: TrumaBend V85S
Hydraulic	: 80 ton
Power	: 230 volt
Tonnage	: 850kN
Working path	: 215 mm
Bending length	: 2550 mm

## 2.6 Punching Process

Punching in metal fabrication is the process of using a machine to press a shape through a sheet of metal and into a die to create that shape in the metal. This is most commonly done by use of a turret, a computer numerical controlled machine that houses tools and their corresponding dies in a revolving indexed turret. These machines use hydraulic, pneumatic, or electrical power to press the shape with enough force to cut the metal. This punching process was showed in Figure 2.9.[5]

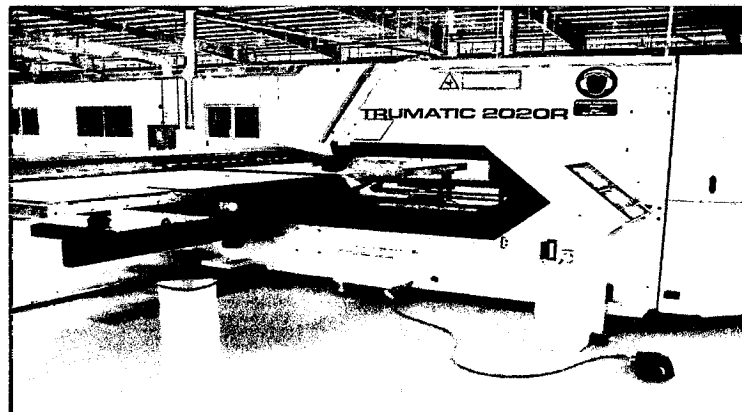


Figure 2.9: Punching process

A misconception about punching is that the shape does the cutting, when in fact the shape presses the material into a die that cuts the metal. The die is also given a tolerance that is measured in thousands of an inch.[5]

Punching can be better understood as pressing the material against a die with a huge force, this force pushes the material into the die and shears off the waste material. The turret punch machine specifications that have in mechanical laboratory are:

Model	: Trumpf Trumatic 2020R
Type	: Tc 2020R
Fuse	: 3 x 40A
Power Supply	: 415V/50Hz
Connected load	: 22kVA
Control voltage	: 24 VDC
Max. Punch capacity	: 180kN

## 2.8 Joining Method

The joining method that used is the permanent joint is a welding joint. The welding machine that is used is from GMAW or Gas Metal Arc Welding type.

### 2.8.1 Turning On

Firstly plug in (most plug into the 220v drop plug). Secondly turn the gas (75% Arc & 25% CO<sub>2</sub>) on all the way. Thirdly turn the power on the welder. Pick up the welding gun and pull the trigger to make sure it is on, and that the wire will feed. Set the gas cylinder regulator at 20 (Cubic Feet per Hour). Use wire cutters to nip the wire off the tip of the welding gun. Open the bonnet of the welder and read the chart on where to set the volts and amps of the welder. Set the volts (do this before the wire speed). Set the