DESIGN AND FABRICATION OF MIG WELDING JIGS

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DESIGN AND FABRICATION OF MIG WELDING JIGS

WONG FEI YONG

Report submitted in partial fulfilment of the requirements
for the award of Diploma in Mechanical Engineering

Faculty of Mechanical Engineering
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DECEMBER 2011

SUPERVISOR'S DECLARATION

I hereby declare that I have checked this project report and in my opinion this project is satisfactory in terms of scope and quality for the award of Diploma in Mechanical Engineering.

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I hereby declare that the work in this thesis is my own except for quotations and summaries which have been duly acknowledged. The thesis has not been accepted for any degree and is not concurrently submitted for award of other diploma.

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ABSTRACT

This thesis deals with the design and fabrication of MIG welding jigs. The objective of this thesis is to develop welding jigs that able to clamp workpiece and reduce the deflection due to thermal stress. At the same time, the welding jigs also able to clamp workpiece with the thickness up to 8mm and 80 mm width. Clamping design and common welding jigs material was studied in order to design and generate concept for the MIG welding jigs. Solid Works was used to design or draw the final concept of the MIG welding jigs. The material used to fabricate these welding jigs is aluminium block. On the other hand, screw clamp was used to design clamping system for the welding jigs. The welding jigs were design in such an order that it able to adjust the gap between workpiece and give out the gap measurement so that the time taken for the welding research can be reduced. Methods and process involve in accomplish this is the machining process by using conventional milling machine, cutting process by using the vertical bend saw, joining process by using screwing, welding process and filing process.

ABSTRAK

Tesis ini membincangkan tentang mereka bentuk dan fabrikasi jig kimpalan MIG. Objektif tesis ini adalah unutk menghasilkan jig kimpalan yang mampu mengapit bahan kerja dan mengurangkan kesan bengkok yang disebabkan oleh tekanan haba. Pada masa yang sama, jig kimpalan ini juga mampu mengapit atau memegang bahan kerja yang mempunyai ketebalan sehingga 8mm dan 80 mm lebar. Reka bentuk system pengapit dan juga bahan-bahan yang dijadikan sebagai jig kimpalan telah diselidik demi menghasilkan reka bentuk dan konsep jig kimpalan MIG. Solik Works telah digunakan dalam untuk melukis konsep akhir bagi jig kimpalan MIG. Blok aluminium telah digunakkan sebagai bahan untuk menghasilkan jig kimpalan. Sebaliknya, pengapit jenis skru telah digunakan bagi mereka sistem pengapit bagi jig kimpalan ini. Jig kimpalan ini direka agar ia mampu melaraskan jarak antara bahan kerja justeru memberikan bacaan jarak terbabit di mana ini mampu menjimatkan masa penyelidik kimpalan. Kaedah dan process yang digunakan dalam menyiapkan projek ini adalah proses pemesinan melalui penggunaan mesin “milling”, proses pemotongan dengan menggunakan gergaji pita, proses pergabungan melalui penggunaan skru, proses kimpalan dan proses pengikiran.

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CHAPTER 1

INTRODUCTION

1.1 PROJECT INTRODUCTION

This project is about the design and fabrication of MIG welding jig. The design will be different from the existing MIG welding jig in the market as this jig was design especially for the use of the MIG welding machine in welding research lab. The same thing applies to the companies such as automotive company who have their own welding jig which is customized for their car model.

This MIG welding jig is fabricated by using stainless steel block, aluminum bar, screws, and steel ruler by the mean of several mechanical processes. These processes are welding process, milling process, drilling, and cutting. This project will be beneficial for the MIG welding researcher who going to use the welding machine in the welding research lab as it will save the time for align the workpieces, reduce thermal stress and able to hold a variety of sheet metal and plate thickness as well as rod.

This welding jig was made in a way that it is easy to use and reliable to the user without limiting the user skill.

1.2 PROBLEM STATEMENTS

Welding jig is important in reducing the effect of defect such as thermal stress in welding part. In the welding research lab, most of the sheet metal that been weld deflected. This will trouble the lecturer research on welding. This is mostly due to the improper welding jig that unable to clamp the sheet metals. Thus, a proper welding jig should be produced as soon as in order to overcome this problem and

help to increase the accuracy of the research been made. The present jig also cannot clamp workpieces with different thickness.

1.3 PROJECT BACKGROUND

MIG welding require a proper alignment of workpieces and griping force in order to obtain a good welding result. Every different workpiece design require a different welding jig. Thus, currently there is no suitable welding jig for the welding machine in the welding research lab.

In order to overcome this, the design of MIG welding jig that is suitable for the welding machine. This project is important in to hold the workpiece together in one straight line and reduce the distortion due to thermal stress. This jig also designed in such order that it is able to clamp different thickness of workpieces as well as rod.

The MIG welding jig will be mounted on the welding table of the welding jig in the welding research lab.

1.4 PROJECT OBJECTIVES

The objectives of this project are:

- To design and fabricate a MIG welding jig that can hold the workpieces such as sheet metal and plate in a rigid position so that the distortion due to thermal stress can be minimized beside can clamp different thickness of workpiece.
- To design and fabricate a MIG welding jig that can hold rod beside sheet metal and plate.

1.5 PROJECT SCOPES

- Function
  - Design for the use of the MIG welding machine in welding research lab.
  - The jig can hold different thickness of workpiece.
  - The jig can hold rod.

- The jig can be move so that a different distance of gap between workpieces can be achieved.
- The jig able to give the measurement for the gap between workpieces.

- Other features
  - Use stainless steel so that it is long lasting.
  - Use milling process, drilling, cutting, and welding process.
  - Materials used: aluminum bar, steel ruler, and screws and bolts.

1.6 PROJECT PLANNING

This project starts with problem identification and further proceeds with literature review and research. The research mainly on the MIG welding and it properties, design of jigs and the material suitable for the jigs. This is done via internet and books. The schedule for the project from the beginning until the final week was made in term of gannt chart.

1.6.1 Project Flow Chart

Figure 1.1 shows the project flow chart for the throughout process in completing this project.

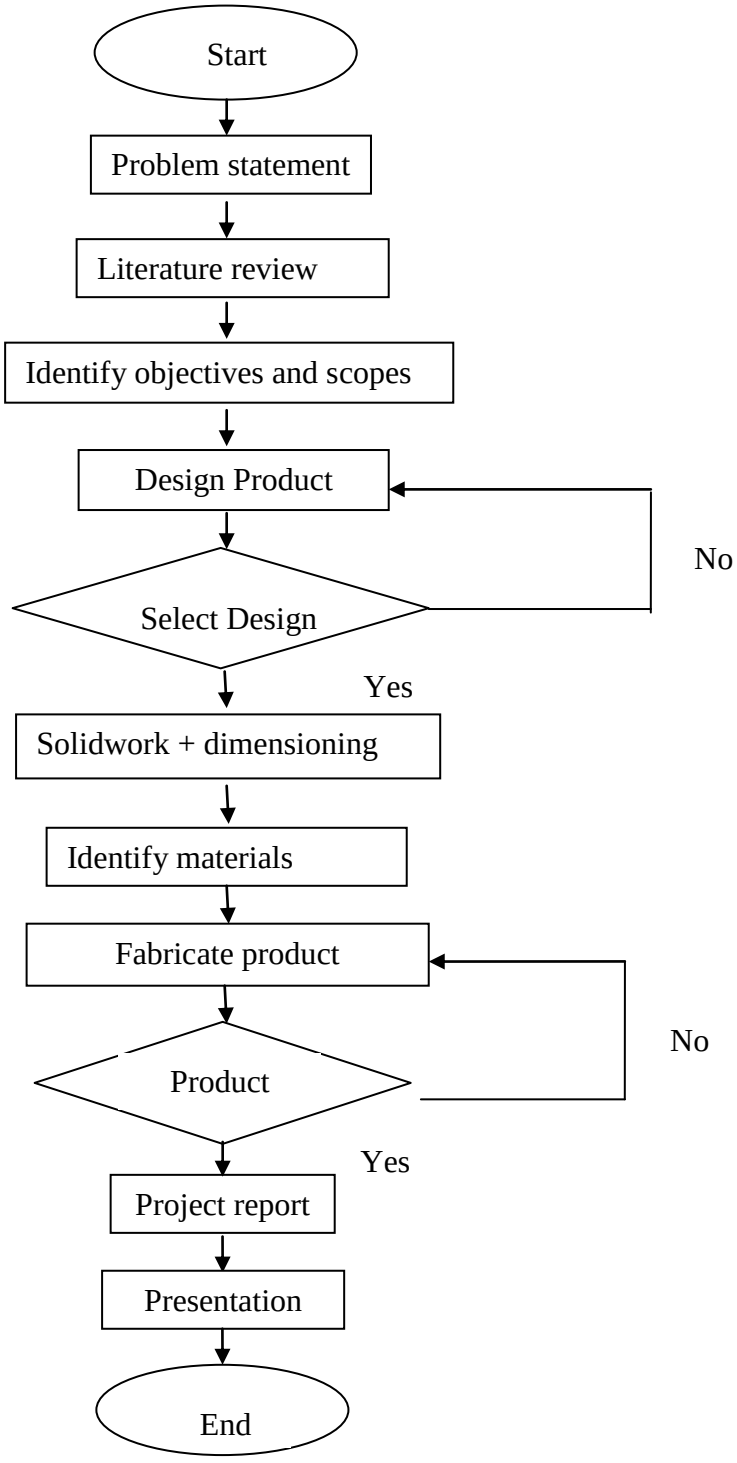

Figure 1.1: Project flow chart

1.6.2 Project Gantt Chart

Table 1.1 shows the gantt chart for MIG welding jigs project.

Table 1.1: Project gantt chart

Task	Week														
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Verify project															
Identify problem statements															
Identify objectives and scopes															
Literature review															
Concept generation															
concept selection															
Analyse and modified concept															
Mid presentation															
Materials selection and Fabrication															
Analyse and refinement															
Report writing															
Final presentation															

Planning	
Actual	

1.7 THESIS ORGANIZATION

Chapter 1 discuss about the project introduction, problem statement, project background, project objective, project scope, project flow chart and project gantt chart. This chapter shows the overview of my project and the project flow.

Chapter 2 is the literature review which mainly discuss about MIG welding, welding jigs and materials which is the important information required before the MIG welding jigs can be designed.

Chapter 3 discuss about the methodology. This chapter discuss on the generation of concepts and concept selection. In this chapter also, the fabrication process was explained.

Chapter 4 elaborates the result and discussion obtained for this project. This chapter also will state on the advantages and disadvantages of the product and problem faced during accomplishing this project.

Chapter 5 explains about the conclusion and recommendation that can be made to the MIG welding jigs.

CHAPTER 2

LITERATURE REVIEW

2.1 INTRODUCTION

As we know, there are a numbers of jigs design was custom made by the welder according to their working condition such as the machine design and the work to be weld. Thus, it is unavoidable that we have to create our own MIG welding jigs according to the specification of the MIG welding machine in the welding research lab. Thus, a study on the jig was made by review the example of jig designs and the information on how the jig should be made and from what it should be manufactured.

2.2 MIG WELDING

Metal inert gas welding (MIG) was also known as gas metal arc welding (GMAW) or metal active gas welding (MAGW). MIG welding process is a semi-automatic process that used consumable wire electrode and shielding gas. The wire electrode was continuously and automatically fed through the welding gun. The wire electrode diameters used in this welding process is around 0.8 to 6.5 mm and it is depend on the thickness of the part to be joined. Gases that normally used as shielding gases can be inert gases such as helium and argon or active gases such as carbon dioxide. Gases used during the welding process depend on the type of metal to be weld where inert gases for aluminium alloys and stainless steels but carbon dioxide for low and medium carbon steels. Shielding gases function to eliminate slag

covering on the welded part. As MIG welding save more time compare to Shielded metal arc welding (SMAW), it is widely used in factories.

MIG welding operate by creating a short circuit between the wire electrode (anode) and the metal being weld (cathode). This short circuit will produce enough heat energy to melt the metal and allow them to join together. The schematic diagram and the picture of traditional MIG welding can be seen as following;

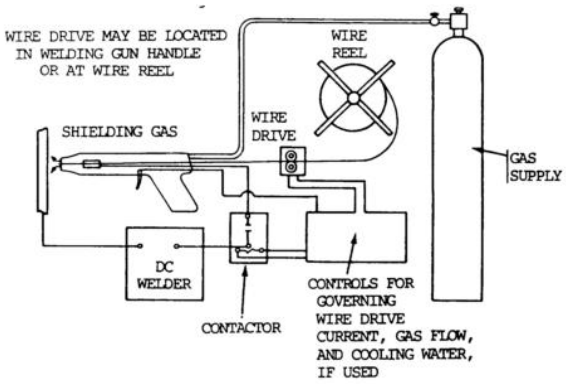

Figure 2.1: Traditional MIG welding machine schematic diagram (weldguru.com)

Figure 2.2: MIG welding machine in welding lab

This is the general information regarding MIG welding. However, in our welding research lab, the MIG welding used is no longer semi-automatic but it is automatically controlled by using PLC where the MIG welding machine table able to move in both X and Y axis according to the welder will. This machine was built under the research of Dr. Mahadzir for research purpose. It requires a different jig compare to traditional MIG welding. The MIG welding machine in the welding research lab is as shown below;

Figure 2.3: Automated MIG welding machine

During the welding process, MIG welding produced spatter which is hot enough to melt the low melting point material such as aluminum. However, spatter is required as it helps to create a good joint between workpieces. Thus, the welding jig should be able to withstand the heat produced by the spatter so that it can last long.

Beside spatter, MIG welding or even any welding process also cause distortion to the workpiece especially in sheet metal which is normally used as the workpiece in welding research lab. Commonly, the distortion can be reduced by using a proper welding jig. The distortion normally as below;

Figure 2.4: Distortion in sheet metal due to MIG welding (MIG Welding – the DIY Guide)

2.3 RESISTANCE SPOT WELDING

Resistance spot welding is a fusion-welding process by using heat and pressure (Mikell P. Groover, 2011). This process was used to join sheet metal with less than 3mm thickness. The principle of resistive spot welding was as shown below:

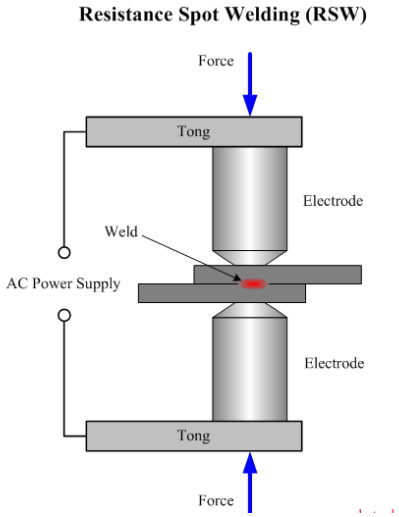

Figure 2.5: Principle of resistance spot welding (SubsTech, 2009)

2.4 WELDING JIGS

Jig is a device used to clamp workpiece in a specific location so that the mechanical process is properly guided. Jigs are independent devices which fastened to the machine table (K Venkataraman, 2005). Jigs are designed in such order that it able to load and unload workpiece easily. Thus, we can said that welding jigs are devices that mounted on the welding table so that it can guide the welding gun and produce a straight perfect welding bead.

Same with other jigs, welding jigs require gripping devices to hold the workpiece in place during welding process through clamping devices. K Venkataraman (2005) has stated that there are various methods to clamp such as threaded fastener, cam clamps, 'V' type sliding clamps, pneumatic clamps, hydraulic clamps, and more. P.H. Joshi (2003) has stated that a clamping system should be strong enough to withstand the forces during operation without damaging the workpiece surface.

2.4.1 Principle of Clamping

There are several things should be considered when designing a clamping system for the welding jig. The things to be considered are the position of the clamping, the strength of the clamping, productivity, operator fatigue, and workpiece variation. First of all, the clamping system of the welding jig must be designed so that it will not obstruct the path of the welding gun as well as the path of loading and unloading of the workpiece.

In term of strength, the clamping device should be able to withstand the forces developed during the operation which is welding operation. The force in welding operation mainly is the distortion of the workpiece due to thermal stress. However, the clamping forces should not damage the workpiece.

Productivity of the welding jig also should be considered by minimizing the clamping time by using hand knobs, tommy bars and more so that it can be tightened or loosened manually without the need for extra tools. This is important so that the researcher can save their time when doing the welding research.

In term of operator fatigue, for clamps that need to often tighten or loosen it is recommended to use pneumatic or hydraulic clamping (P.H. Joshi, 2003). However, due to the cost constraint the welding jigs will only use manual method to tighten or loosen the clamp.

Lastly, the clamping system of the welding jigs should be able to hold a variety of workpiece.

2.4.2 Types of Clamps

There are several types of clamp that usually used such as the screw clamps, pivoted clamps, hinged clamps, swinging clamps, quick action clamps, multiple clamps, power clamps and non-conventional clamps (P.H. Joshi, 2003). However, there are only four main types of clamps being refer during the design of the MIG welding jigs clamps. These four clamps are hinged clamps, quick action clamps, screw clamp and hydraulic clamping. These three clamps are as shown below;

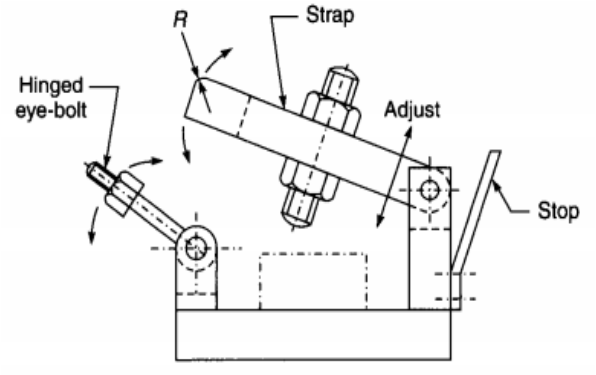

Figure 2.6: Hinged clamp (Prasad Ghorpade, 2011)

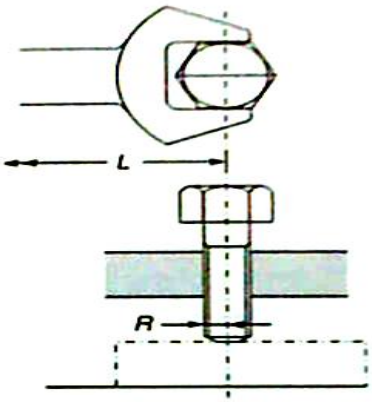

Figure 2.7: Screw clamp. (P.H. Joshi, 2003)

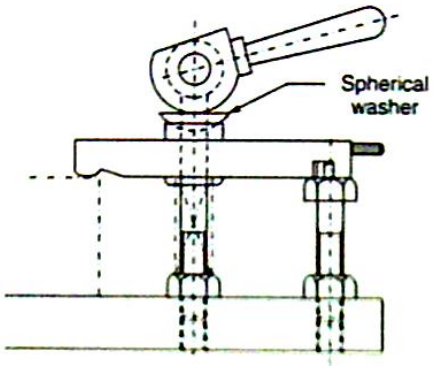

Figure 2.8: Quick action clamp (P.H. Joshi, 2003)

Figure 2.9: Hydraulic clamp (Alibaba.com, 1999 – 2000)

2.4.3 Consideration in Designing Welding Jig

When design for the MIG welding jigs, we must consider:

1. Expansion of the workpiece due to the heat during welding should not affect the clamping effect of the jig.
2. Do not allow the spatter to fall on threaded part of the jigs so that it will not jam.
3. Ensure that the workpiece can be unload from the jig as soon as the welding process finish.
4. Provide a spatter grooves so that the workpiece will not join together with the base plate.

2.5 MATERIAL

Jigs are made from various types of material such as high speed steels (HSS), die steels, carbon steels, collet steels (spring steels), phosphor bronze, nylon and fibre, steel castings, mild steel, cast iron, high tensile steels, case hardening steels and oil hardening non-shrinking tool steels (OHNS).

Different materials are used for different application of jigs. For welding jigs, the normally used materials are aluminum (hot and cold rolled), stainless steel, copper and bronze.

2.5.1 Materials Characteristics

The material characteristics of the common materials used in making the welding jig are listed in Table 2.1.

Table 2.1: Physical and thermal properties of aluminum, stainless steel, copper and bronze. (efunda.com, 2011 and lenntech.com, 1998 – 2011)

Material	**Aluminum**	**Stainless steel**	**Copper**	**Bronze**
Density (x1000 kg/m^3)	2.71	8.03	8.94	7.8 – 8.8
Melting point (℃)	660.3	1371 - 1399	1085	1050
Boiling point (℃)	2519		2562	-
Thermal expansion coefficient (x10^{-6}/℃)	23.0	17.2	16.6 – 17.6	18.0 – 21.0

From Table 2.1, we can see that different materials have different characteristic. The melting point of stainless steel is the highest among the four materials and it is the second lightest material among the four materials.

Thermal expansion coefficient indicates how much a material expands for each degree the temperature increase. From the table above, stainless steel has the second lowest thermal expansion coefficient after copper which mean it will only involve a slight expansion due to the heat.

Thus, we can conclude that the most suitable material to be use as MIG welding jigs in this project is stainless steel which will be able to withstand the high

temperature of the spatter produced during MIG welding beside has lower weight than other two metals and less expansion due to increase of temperature.

CHAPTER 3

METHODOLOGY

3.1 INTRODUCTION

In this chapter, it discussed about the process involve in designing and fabricating the MIG welding jigs. This chapter will include the generation of concepts which will be able to solve the problem in problem statement. Besides, this chapter will include on the evaluation of each concept and the final concept selection process. Material selection and fabrication process of the project will also being discussed.

3.2 SUMMARY

In designing and fabricating the MIG welding jigs, 5 concepts were designed in order to find for the best concept. After that, a concept screening process was used to help the concept selection process where concept E was chosen. The project methodology then proceed with the materials selection where the jigs will be fabricate by using stainless steel, aluminum, screws and nuts, and steel ruler.

The machines and tools used in fabricating the MIG welding jigs are CNC milling machine, bendsaw cutting machine, milling machine, hand drill and measuring tape.

3.3 PROJECT FLOW

This section will explain on how this project flow or the steps involved in finalizing the project.

Figure 3.1 shows the complete project flow in completing this project

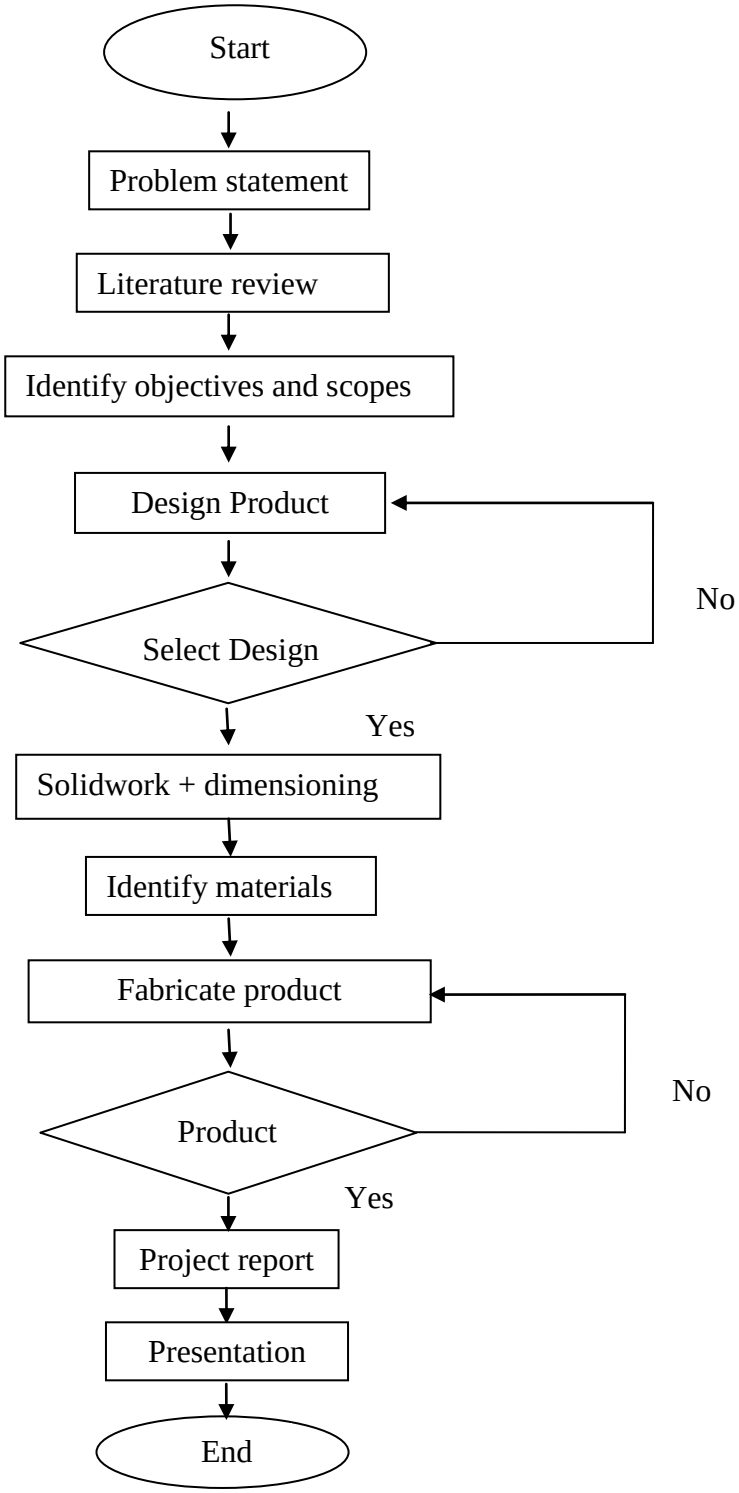

Figure 3.1: Project flow chart

From the flow chart above, this project start with the identification of problems faced by the welding researcher which use the welding machine in welding research lab in clamping the workpiece and the distortion of workpiece. In order to come out with the best concepts, literature review and research on the characteristics of MIG welding, welding jigs and common materials used to fabricate welding jigs was carried out.

Before come out with concepts, objective and scope of the project was determined so that the process of concepts generation will be easier and more effective. After that, 5 concepts were generated and one final concept was chosen by using the concept screening method. Base on the flow chart, if there are no suitable design then the process of generating concepts will continue. After final concept was chosen, it will be draw by using solidwork and dimension will be given.

The processes continue with material selection which is base on the common materials used in market which is stainless steel, aluminum, screws and nuts, and steel ruler. Then, it will continue with the fabrication process which mainly used the CNC milling machine, milling machine, lathe machine, hand drill, bendsaw cutting machine, and measuring tape. After that, the product will be evaluated for any correction. Lastly is to finish the report according to the due date and perform final presentation.

3.4 CONCEPT GENERATION

3.4.1 Concept Generation for MIG Welding Jigs

After gather all the necessary data, 5 concepts were generated by hoping that it will solve the problems in problem statement. These 5 concepts named as concept A, concept B, concept C, concept D and concept E.

Concept A

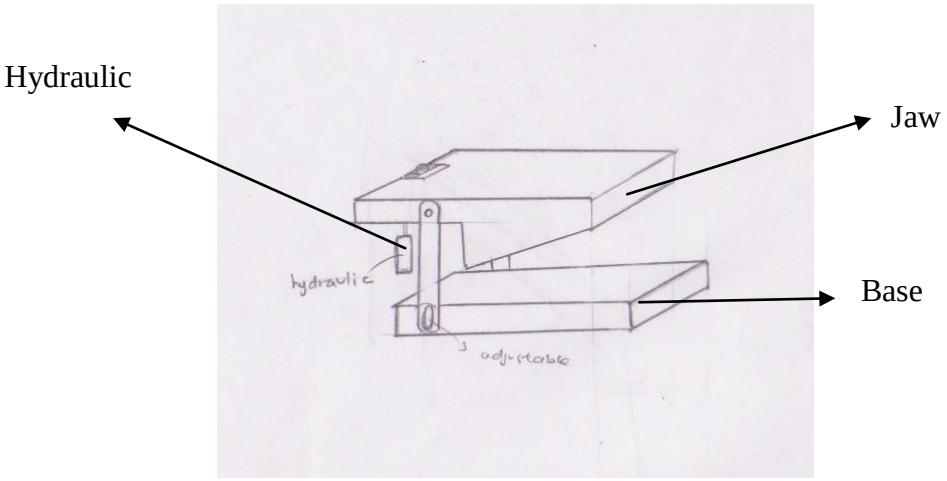

Figure 3.2: Concept A

Figure 3.2 shows the first concept generated. The advantages of this concept are that it was designed by implementing the hydraulic system to open and close the clamp. Hydraulic system was chosen during designing this jig because it able to provide an exact clamping force on the workpiece whilst able to save the users time for clamping and unclamping the jigs. Besides, this concept can clamp various thicknesses of workpieces. Lastly, it is easy to manufacture as the parts involved are not complicated and only consist of 5 main parts. However, by applying the hydraulic system in the jigs will increase the cost.

Concept B

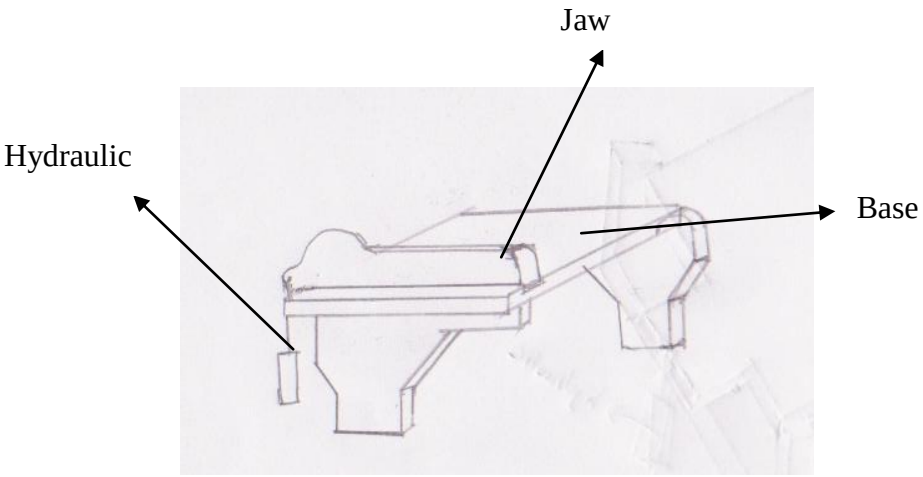

Figure 3.3: Concept B

Figure 3.3 shows the second concept. This concept was designed by referring to the Mitsubishi Pajero CS7 Welding Jigs as shown in figure 2.8 and modified it. The advantages and disadvantages of this concept are same with concept A as it uses the same system.

Concept C

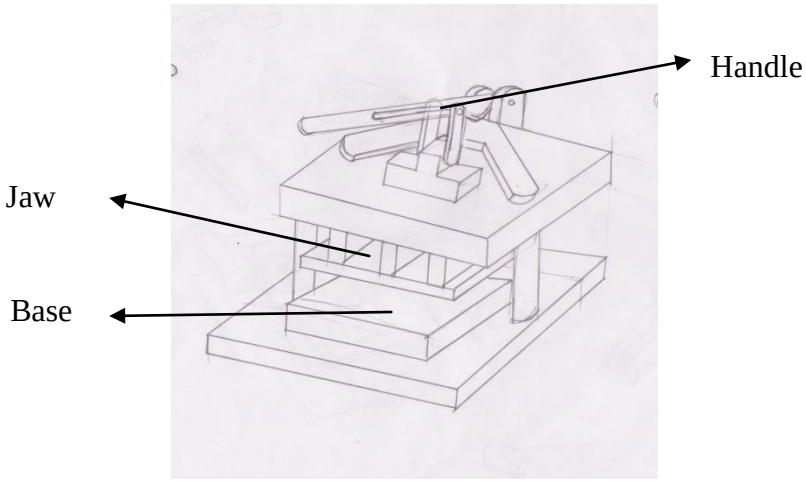

Figure 3.4: Concept C

Figure 3.4 shows the third concept. This concept was designed base on the quick action clamp. The advantages of this concept are it's able to hold various thickness of workpiece. Besides, by using quick action clamp to tighten the handle the time taken to clamp and unclamp the jig will be lesser compare to screw clamp. This concept significantly cheaper than both concept A and B. However, this involves complicated assembly compare to the other 2 concepts.

Concept D

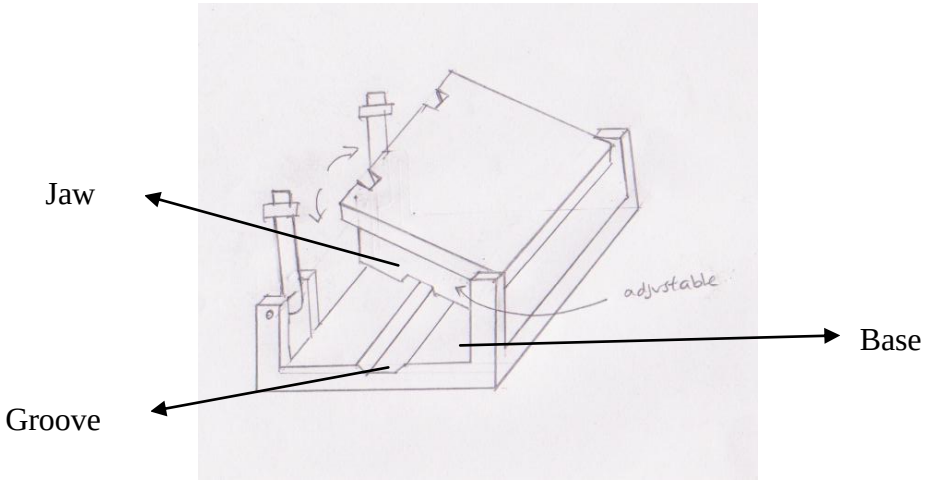

Figure 3.5 Concept D

Figure 3.5 shows the fourth concept. This concept was designed by using the hinged clamp. The advantages of this concept are it's able to hold various thicknesses of workpiece as well as rod. Besides, this concept also easy to manufacture as it involve less complicates part. However, this concept take a longer time to tighten the clamps compare to others concepts.

Concept E

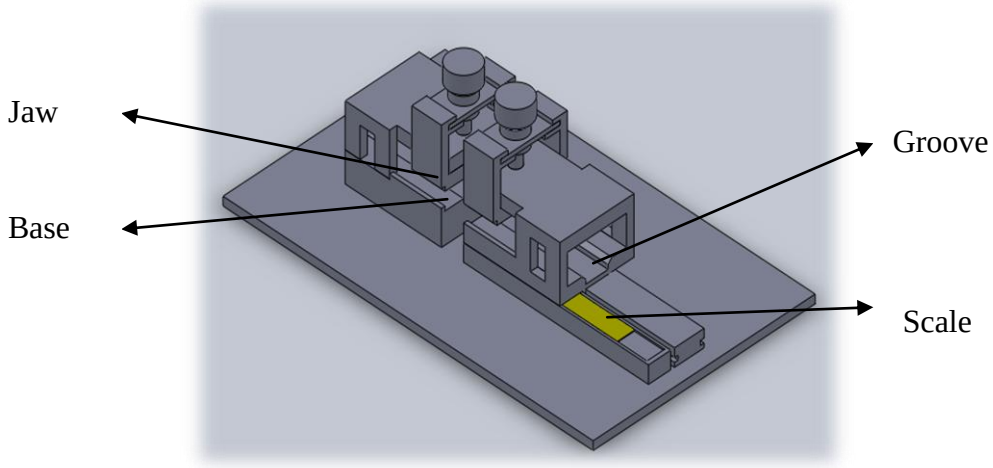

Figure 3.6: Concept E

Figure 3.6 shows the last concept generated. This concept was designed by using the screw clamp which is the cheapest clamp type. The advantages of this concept are it's able to clamp workpiece with different thickness as well as rod. Besides, compare to the other 4 designs this design have two main extra features which is it able to adjust the gap between workpiece and give out the measurement for the gap. However, the disadvantages of this design are it involves several complicated parts and take a longer clamping time compare to hydraulic clamp system.

3.4.2 Concept Generation for Resistance Spot Welding

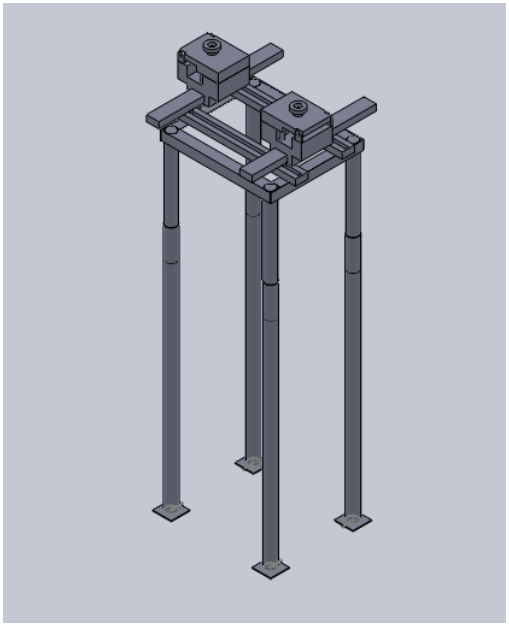

Figure 3.7: Spot welding jigs.

Figure 3.6 shows the concept generated for the resistance spot welding. This concept was designed by using the screw clamp which is the cheapest clamp type. The advantages of this concept are able to clamp workpiece with different thickness and the table height was adjustable. However, the disadvantage of this design is it takes a longer clamping time compare to hydraulic clamp system.

3.5 CONCEPT SELECTION

3.5.1 Concept Screening

Concept screening is a method developed by Stuart Pugh in the late 1980s to help narrowing the number of concept. This method was also known as Pugh Concept. Table 3.1 shows concept screening for narrowing the number of the 5 concepts generated. In this process, concept C was chosen as reference concept. The screening process considers several criteria which are durability, cost, ease of manufacturing, ease of operating, space optimization and functionality. The relative score for each concept according to criteria was placed as “better than” (+), “same as” (0), or “worse than” (-). All the score given for each concept is according to the comparison with reference concept. After sum the total score, concept E shows to be the best concept for manufacture as MIG welding jigs. Concept scoring was not

needed for this case as concept screening alone able to provide a clear vision for which concept to be chosen.

Table 3.1: Concept screening

	CONCEPT VARIANTS				
SELECTION CRITERIA	A	B	C (ref.)	D	E
Durability	0	0	0	0	0
Cost	-	-	0	0	0
Ease of manufacture	-	-	0	+	+
Ease of operating	+	+	0	0	+
Space optimization	+	0	0	0	0
Functionality	0	0	0	+	+
PLUSES	2	1	0	2	2
SAMES	2	3	6	4	4
MINUSES	2	2	0	0	0
NET	0	-1	0	2	3
RANK	3	4	3	2	1
CONTINUE	No	No	No	No	Continue

3.5.2 Final Concept

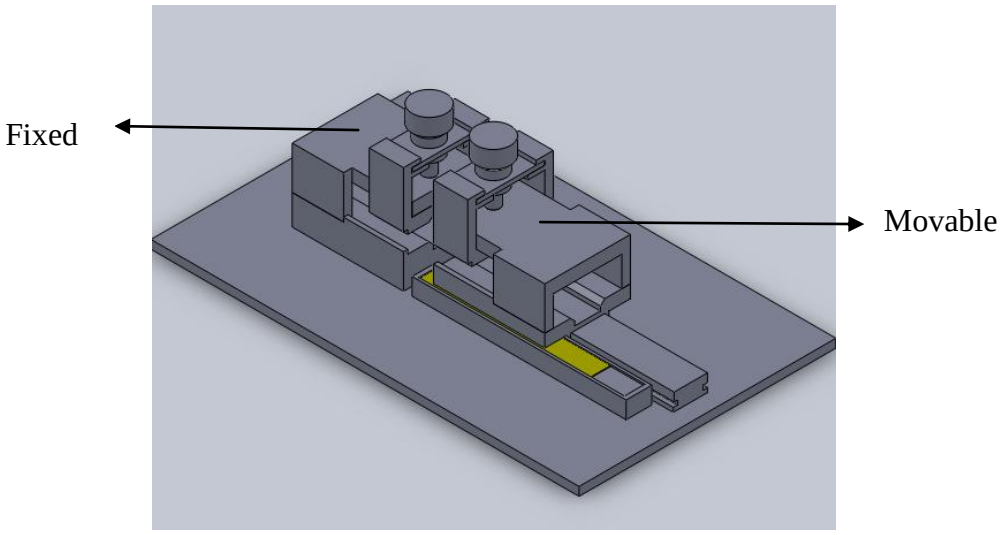

Figure 3.8: Final Concept

Figure 3.8 shows the final concept chosen to be fabricated as MIG welding jigs. By referring to table 3.1, final concept which is concept E shows the most outstanding characteristics where there are no characteristics of this concept that

worse than reference concept. This concept will be made from stainless steel as this material posses the best characteristic for welding jigs as shown in table 2.1. However, due to the lack of stainless steel aluminum will be used. By installing a steel ruler as scale as shown in figure 3.6, this welding jigs can give out the measuring between the gap so that the researcher can determine the best gap measurement for producing a good welding. The complete step on how to get the measurement of the gap by using this scale was clearly stated in chapter 4. Base on this concept, one of the jigs is fixed while the other jig can be moved so that we can adjust the gap between workpiece.

As for final concept for resistance spot welding, it can be refer to figure 3.7.

3.6 LIST OF USED MATERIALS

This table aim to provide the information regarding the material used, dimension and quantity for the MIG welding jigs.

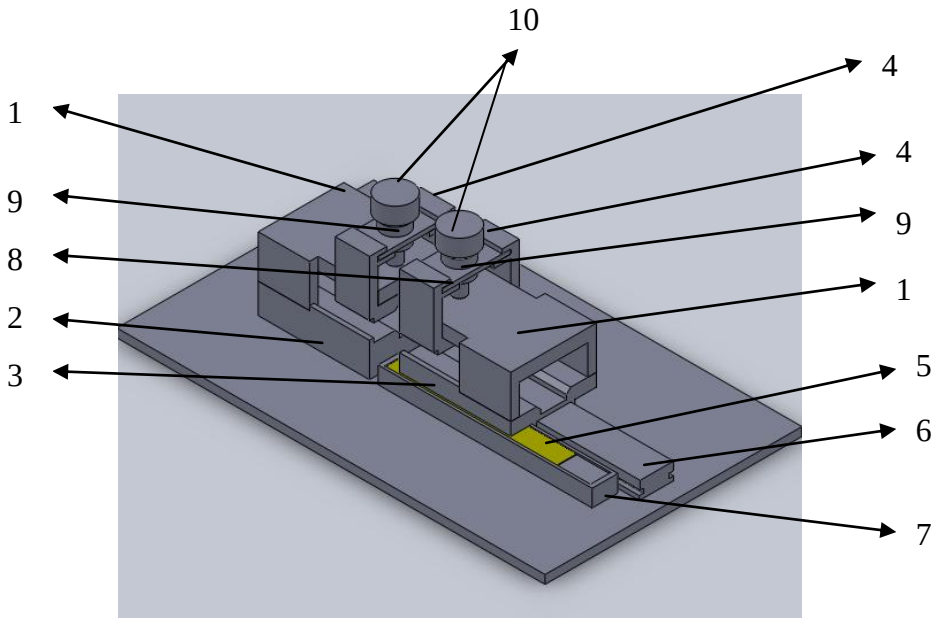

Figure 3.9: Final Concept

Table 3.2: List of used materials (MIG welding jigs)

Part	Material	Dimension (cm)	Quantity
1	Aluminum block	10 x 13 x 5	2
2	Aluminum block	10 x 13 x 4	1
3	Aluminum block	10 x 13 x 3.5	1
4	Aluminum block	10 x 4 x 7	2

Table 3.2: Continued

5	Steel (steel ruler)	15	1
6	Aluminum block	4 x 25 x 2	1
7	Aluminum block	3 x 25 x 2	1
8	Aluminum plate	4 x 8 x 0.5	2
9	Mild steel rod	Ø3 x 1	4
10	Mild steel rod	Ø4 x 2	2
Screws and nuts	Iron	M8	2

The part number in table 3.2 can refer to figure 3.9.

Table 3.3 shows the material used, quantity and dimension for the resistance spot welding jigs.

Table 3.3: List of used materials (resistance spot welding jigs)

Material	Dimension (cm)	Quantity
Aluminum block	10 X 10 X 13	2
Hollow square (mild steel)	35 X 35 X 80	4
Round hollow (mild steel)	Ø32 X 36	4
Aluminum bar	50 X 30 X 40	4
Screws and nuts	M8 X 4	4
	M10 X 2	2

3.7 FABRICATION

After finish with the conceptualization process, material selection and material measurement, this project was proceeding with fabrication process. The fabrication process can be divided into nine phases, which are:

1) Phase 1 – Material selection and determine parts dimensions
2) Phase 2 – Material cutting process
3) Phase 3 – Milling process
4) Phase 4 – Filing process
5) Phase 5 - Drilling process
6) Phase 6 – Threading process
7) Phase 7 – Welding process
8) Phase 8 – Joining all the parts
9) Phase 9 – Finishing

3.7.1 Material Selection and Determine Parts Dimensions

The material selected to fabricate the MIG welding jigs are mainly consist of aluminum which is in term of block although it is initially planned to use stainless stee l as it able to withstand high temperature and low rate of expansion due to heat produced during welding. This is due to unavailability of the stainless steel.

After that, all the dimensions of the parts were calculated base on the final concept dimensions. The dimension required by each of the parts for MIG welding jigs are as shown in table 3.2 and for the resistance spot welding jigs are as shown in table 3.3.

3.7.2 Material Cutting by Using Vertical Bandsaw

Figure 3.10: Vertical bandsaw

Figure 3.10 shows the vertical bandsaw in the centre store. By using this machine, the aluminum block was cut into the desired dimension. The aluminum blocks obtained from this lab has the initial dimension of 100mm X 100mm, 90mm X 90mm and 50mm X 30mm.

3.7.3 Milling Process

Figure 3.11: Conventional milling machine.

Figure 3.11 shows the vertical conventional machine in milling lab. By using the vertical milling machine, all the raw aluminum was milled into the desired shape. Conventional vertical milling machine was chosen instead of CNC milling machine as these parts was relatively easier to be machined by using conventional milling machine.

3.7.4 Filing Process

Figure 3.12: Remove burs.

Figure3.13: Removing radius in one of the component.

Figure 3.12 and figure 3.13 shows the example of filing process in fabricating this project. Figure 3.12 shows the deburring process which is important to remove the sharp edges and bur beside necessary to create an accurate machining process. On the other hand, figure 3.13 shows the process of removing radius from the two main parts of the MIG welding jigs in order to create sharper corners by using filing process.

3.7.5 Drilling Process

Drill press was used to drill holes for creating the path for threading in order to insert the screws for joining the parts into jigs.

Figure 3.14: Drill holes by using drill press.

3.7.6 Threading Process

Figure 3.15: Threading for M8 screws.

Figure 3.15 shows the threading process for the project. Threading process is used to create threading in the hole that been drilled beforehand in order to enable the screwing process.

3.7.7 Welding Process

Welding process was used to join the screws with caps in order to form a screw clamp for the jigs and to create a lock to lock the movement of the jig after gap measurement between workpiece has been determined. Beside, the welding process also used to joint the table of resistance spot welding.

Figure 3.16: Welding screw and cap.

3.7.8 Joining Process

After all the parts have been machined and the holes for screw have been machined, all the parts were joined by the mean of screwing process. Screwing method was chosen to replace the welding process for joining the parts is because it is relatively faster and allow a better control of accuracy. Besides, the TIG machine which is used for joining aluminum base materials was not in condition.

Figure 3.17: Joining of two parts by using screws.

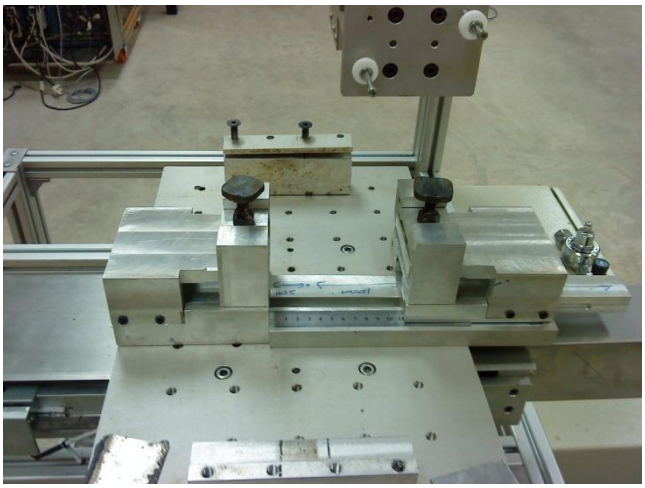

Figure 3.18: Assemble of welding jigs on the welding table by using screws.

3.7.9 Finishing

For the finishing parts, dirt, grease and contaminant was removed from the MIG welding jigs. The MIG welding jigs was then assembled on the welding table of

the MIG welding machine. Painting also used for finishing process for resistance spot welding jigs.

Figure 3.19: Wiping one of the parts after the cleaning process.

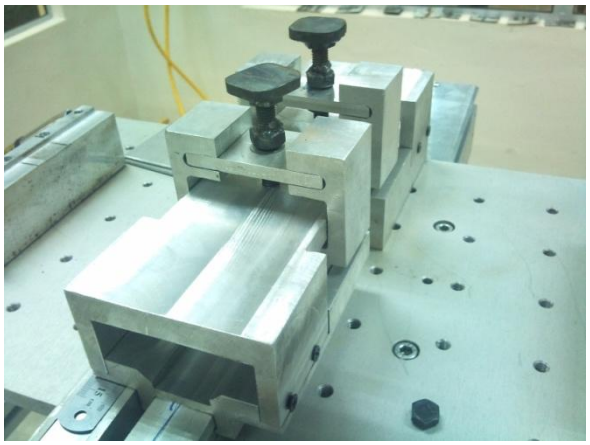

Figure 3.20: Completed MIG welding jigs which mounted on the welding table.

CHAPTER 4

RESULT AND DISCUSSION

4.1 INTRODUCTION

This chapter provides the explanation on the result and discussion for MIG welding jigs and resistance spot welding jigs. In this chapter, the specification and how the jigs work also been explained. Lastly, this chapter also will discuss on the problem encountered during the designing and fabricating process as well as the limitation of the jigs.

4.2 RESULT

4.2.1 MIG Welding Jigs

The finalize result is as shown in the finalize concept in figure 3.7 where the jigs consist of two, one fixed and another one moveable. These two jigs were mounted on the middle section of the welding table in order to prevent the table failure due to stress. From overall, the welding jigs were made by joining 12 main parts together.

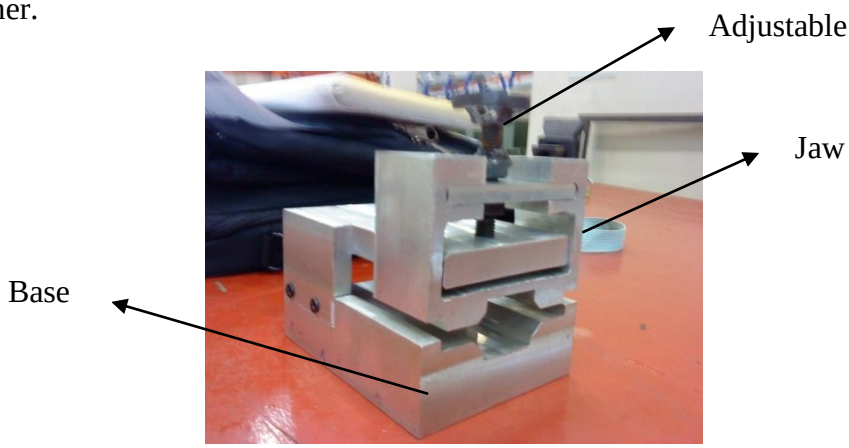

Figure 4.1: Isometric view for the fixed jig.

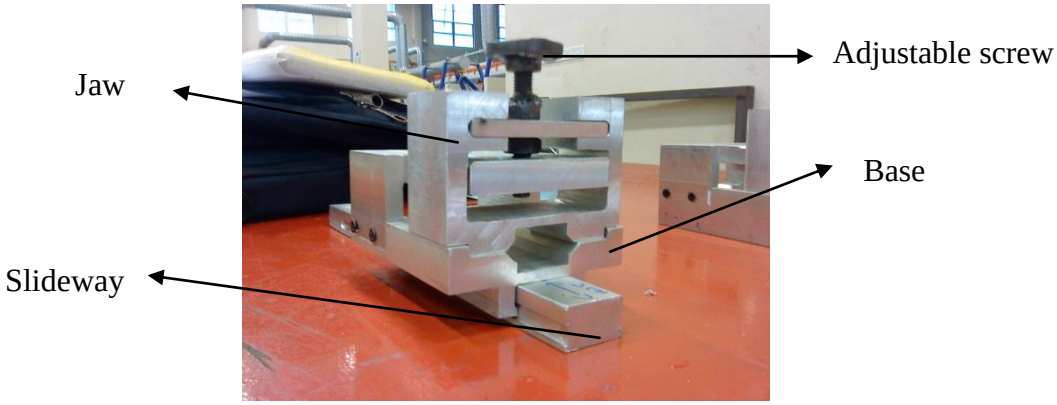

Figure 4.2: Isometric view for the movable jig.

Figure 4.3: Scale assembly.

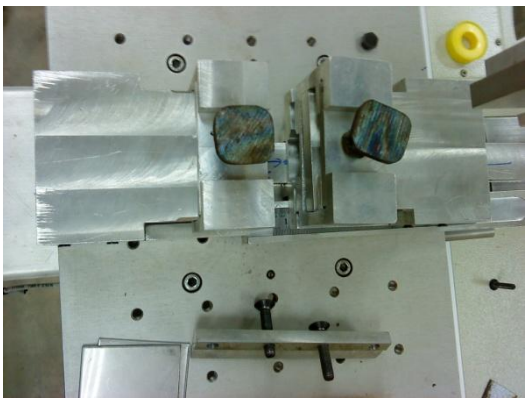

Figure 4.4: Top view of the MIG welding jigs when mounted on the welding table.

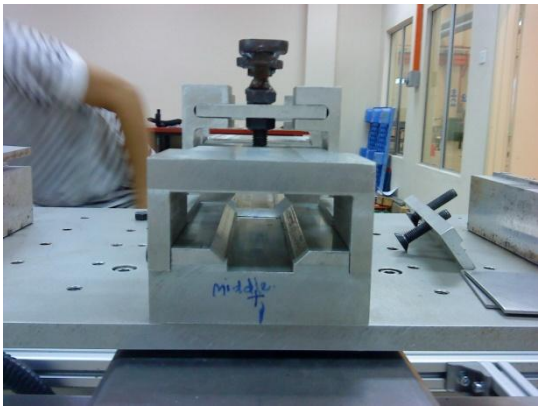

Figure 4.5: Front view of the MIG welding jigs when mounted on the welding table.

Figure 4.6: Side view of the MIG welding jigs when mounted on the welding table.

Figure 4.7: Back view of the MIG welding jigs when mounted on the welding table.

4.2.2 Resistance Spot Welding Jigs

The finalize result is as shown in the finalize concept in figure 3.7 where the jigs consist of two and moveable. These two jigs were mounted on the adjustable table which can change the height according to the will of user. The result was as shown in figure 4.8.

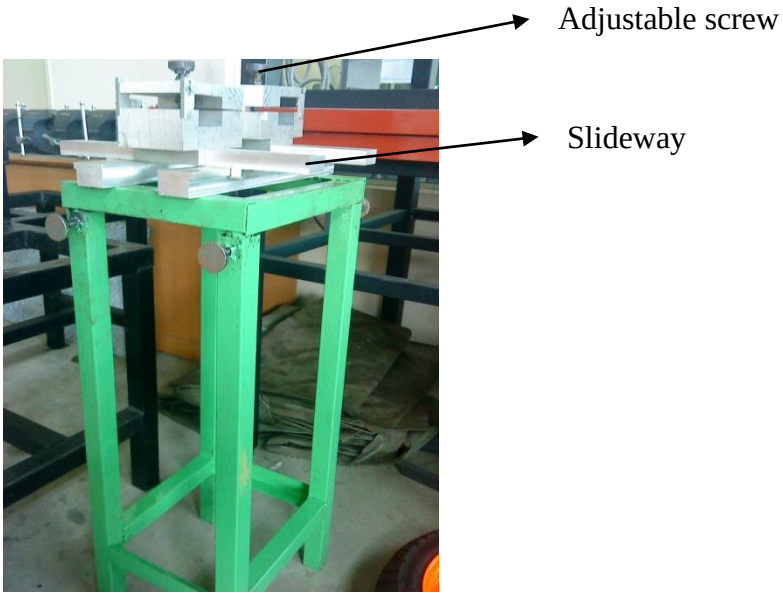

Figure 4.8: Resistance spot welding

4.3 DISCUSSION

4.3.1 Product Specification

The functions of the main parts of the MIG welding jigs and resistance spot welding jigs are as below:

Table 4.1: MIG welding jigs and resistance spot welding jigs parts function.

Part	Function
Adjustable screw	• To loosen the jaw. • To tighten the jaw.
Jaw	• To clamp workpiece along with the base.

Table 4.1: Continued

Base	• Act as a base which proved a reference point to place workpiece and work together with the jaw to clamp workpiece.
Slideway	• Enable the jig to move along the slide direction.
Scale	• Allow the user to determine the measurement of the gap between workpiece.

4.3.2 Product Operating Procedure

Same as any other equipments or devices that have their own operating procedure, the MIG welding jigs also have its own operating procedure that have to follow in order to get the best result. The step was as below:

1) Move the movable jig away from the fixed jig as shown in figure 4.9 in order to insert workpiece into the jaws.

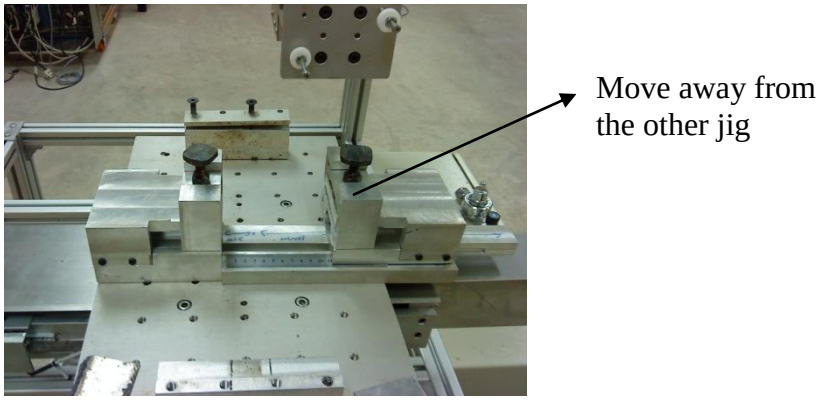

Figure 4.9: Move the jig away from each other.

2) Open the jaw of the welding jigs by turn the adjustable screw in anticlockwise direction.
3) Place the workpiece between the base and the jaw as shown in figure 4.10.

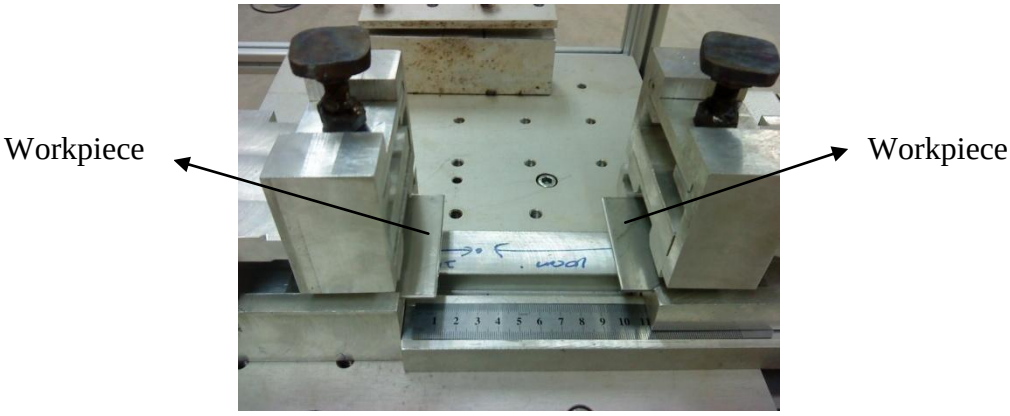

Figure 4.10: Place workpiece between the base and jaw.

4) Adjust the length of workpiece to stay outside of the jaw according to the will.
5) Clamp the workpiece by rotating the adjustable screw in clockwise direction until it is tight.
6) Bring the workpiece and touch with each other by moving the movable jig as shown in figure 4.11 in order to set zero in for determining the gap measurement.

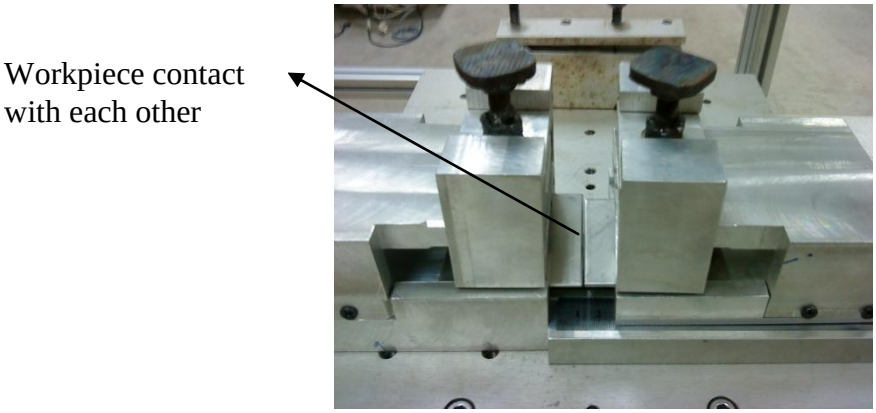

Figure 4.11: Set zero or reference point.

7) Set the scale to zero or any dimension such as 1 cm as reference according to the will of the user by referring the edge of the jig as reference point as shown in figure 4.12.

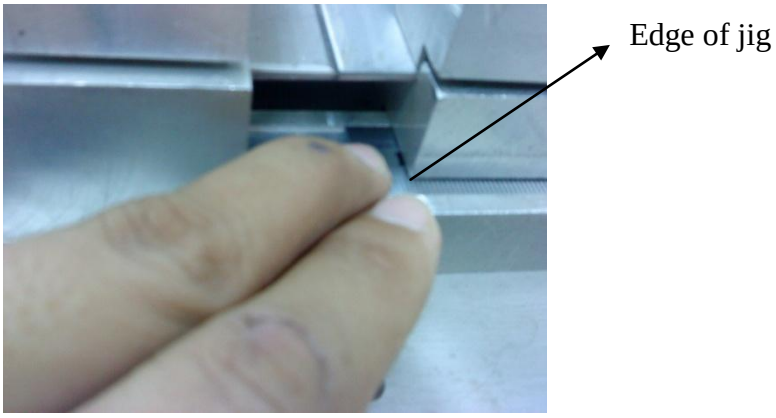

Figure 4.12: Set a reference point.

8) Then, move the jig to the distance desired and obtain the gap measurement as shown in figure 4.13. Base on the previous reference where the position at 1cm was set as the zero point in step 7, by subtract 1.2cm with 1cm the gap measurement will be 0.2cm or 2mm.

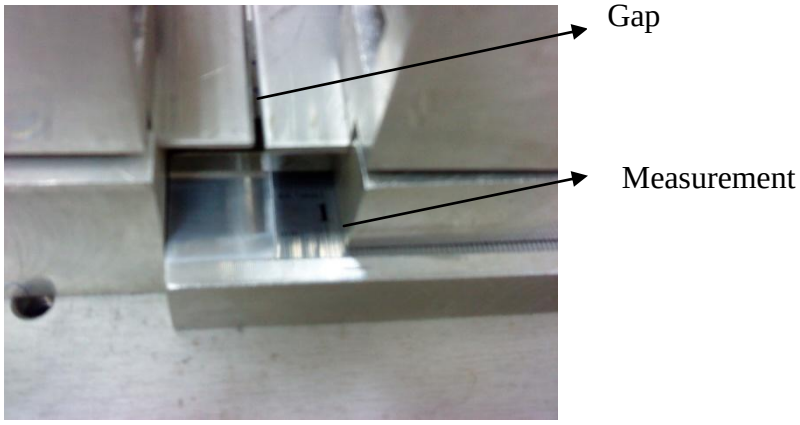

Figure 4.13: Set workpieces gap.

9) After the welding process, loosen the adjustable screw at the jig that is fixed as shown in figure 4.14.

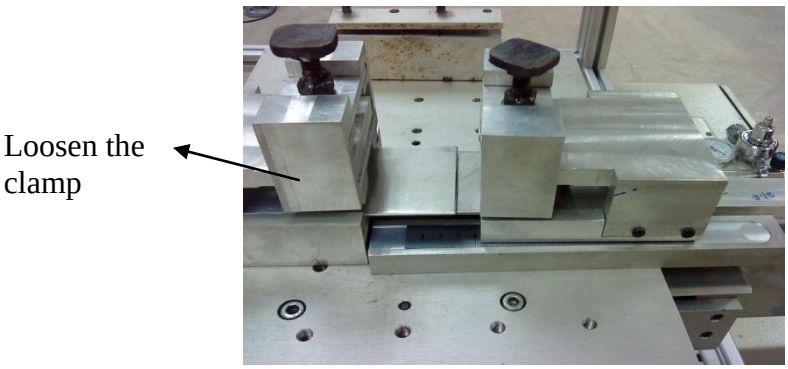

Figure 4.14: Loosen the clamp at the fixed jig.

10) Slide the movable jig away from the fixed jig to take out the workpiece.

4.3.3 Problem Faced and Solution

During the fabrication of the MIG welding jigs, there are two main problems faced. However, these problems have been encountered by taking the best countermeasure.

The first problem been encounter is the unavailability of stainless steel block which is one of the best material to be use to fabricate a welding jig. This is because stainless steel has a high melting point which can resist the heat produced by the spark during welding process. Besides, stainless steel also has a low thermal expansion coefficient which mean it expand less with the increase of temperature. However, due to the unavailability of the material and after consult with the supervisor, stainless steel was replaced with aluminum although aluminum not the best material to be use.

The next problem is during the machining process where the slotting part is unable to be machined by using milling machine due to the lack of the tooling for slot. This problem also been faced during the fabrication of resistance spot welding jigs. Besides, there is part that should have a rectangular in shape but due to the nature characteristic of the tool, sharp corner cannot be made. Thus, in order to create the slotting and sharp corner, filing process was used.

4.3.4 Product Advantages and Functions

As this MIG welding jigs were designed and fabricated to overcome all the problems in the problem statement in chapter 1, thus its main advantages or purpose is to overcome the deflection and increase the accuracy of welding result.

Besides, this welding jigs also designed for be able to measure the gap measurement between two workpiece by following the steps in section 4.3.2. Thus, this can eliminate the time and effort of the welding researcher to measure the gap between workpiece.

The next advantages of these welding jigs are it able to adjust the gap between the workpiece by moving one of the jig along the slide way. This allows the

researcher to determine the best welding gap for each material according to the material thickness.

Furthermore, this MIG welding jigs also able to hold workpiece of various thicknesses from 1mm thickness sheet metal to 8mm thickness plate. This welding jigs also able to clamp rod which is either square or rectangular rod or even round rod up the thickness or height of 25mm.

On top of that, by using the screw clamp for the clamping system of this welding jigs it helps to simplifies the step and procedure to use the welding clamp. Beside, screw clamp has a good clamping force when we compare it with other type of clamp in term of cost.

4.3.5 Product Disadvantages or Limitation

There are several disadvantages or limitation in the design of the MIG welding jigs. Some of the disadvantages were as below.

First of all is the dimension of the section for placing the workpiece which is relatively small where it can only fit workpiece with at most 30 mm width sheet metal or plate. Thus, this limits the size of the workpiece or specimen to be use for the welding research.

The material used to fabricate the welding jigs also is one of the disadvantages that the welding jigs have. This is because the usage of aluminum as the part of the jigs was not effective as the spark produced during the welding process may actually melt the contacted site of the welding jigs. However, due to the limitation of materials available, the usage of aluminum was preceded.

4.3.6 Defect in the Welding Jigs

Due to the limit of skills in fabrication process, there are several defects in the product. These defects were as shown below:

Figure 4.15: Defect due to welding.

As shown in figure 4.15, due to the lack of skills in using arc welding the welding was not perfect. Although the welding are strong enough to withstand the force applied but the imperfect welding make it look dirty and messy. The welding defect can be eliminated by improving the welding skill through practices.

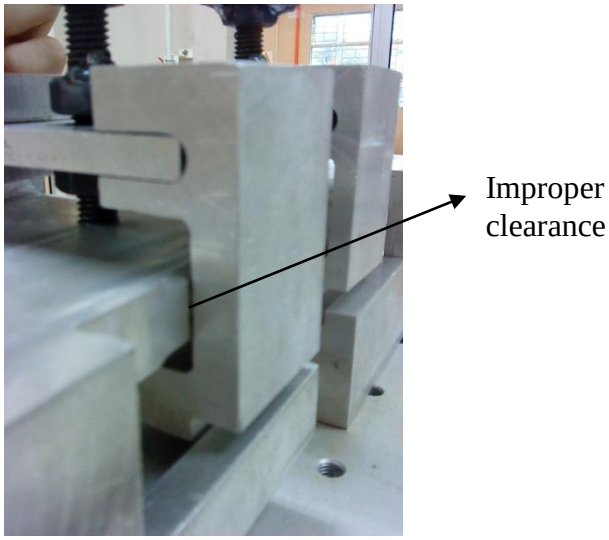

Figure 4.16: Improper clearance.

The next defect was as shown in figure 4.16 where the clearance was too large. This cause unstable of the clamping and unclamping process where the jaw tend to shaken. This can be eliminated by provide a proper tolerances during designing the welding jigs and ensure to minimize the error during the machining process.

Figure 4.17: Inaccurate machining.

Furthermore, there is a defect in term of machining accuracy as shown in figure 4.17 where the chamfer produced was not accurate. This is due to the lack of use of chamfering tool during the machining process during the Mechanical Lab 1 class. The defect can be eliminated by moving the chamfer tools out for about 2mm from the real coordinate as the flat surface of the tools was 2mm in dimension.

CHAPTER 5

CONCLUSION AND RECOMMENDATION

5.1 INTRODUCTION

This final chapter will state on the conclusion and recommendation of the MIG welding jigs. The conclusion was concluded base on the overall process involved in designing and fabricating the MIG welding jigs. Besides, there is also some recommendation for the improvement of the MIG welding jigs and resistance spot welding jigs.

5.2 CONCLUSION

As a conclusion, the objectives of this project have been achieved where this project help me in polish my problem solving skills, fabrication skills, improve my communication skill as well as time management skills and successfully designed a MIG welding jigs which in overall able to achieve the target set during the beginning of the project.

During completing this project, I have faced a number of obstacles in obtaining the raw materials, time constraint and the availability of milling machine. All these problems took me a lot of hardship and planning in order to complete it in the time duration given.

5.3 RECOMMENDATIONS

The MIG welding jigs that been designed is not perfect enough where there are still a number of improvement can be made in order to make it more useful and effective. The improvements can be made are as below:

1) The clamp for the clamping system of the welding jigs can be change into hydraulic clamp as it is better and more efficient when involve a frequent clamp and unclamp action.
2) The jigs designed should provide a bigger and larger space for placing workpiece where 80 mm width is relatively small.
3) The scaling or the gap measurement should be modified and improved where there it should be placed at the position which easier the user to get the reading instead of current position which is hard to get reading and increase the possibility of parallex error.
4) The material used also can or should be change for a better usage result as well as a service timeline. The material recommended was as mention in previous chapter which is stainless steel.

On the other hand, the resistance spot welding jigs also not perfect and there are some improvement can be made. These improvements are:

1) The clamping system should be improved as for the current design; the clamp will deflected when tightened due to the lack of spring as originally designed. Thus, by installing the spring it is believed that the problem can be overcome.
2) The table also can be improved by using hydraulic system or pneumatic system as so that the height can be changed in an easier and more accurate way.

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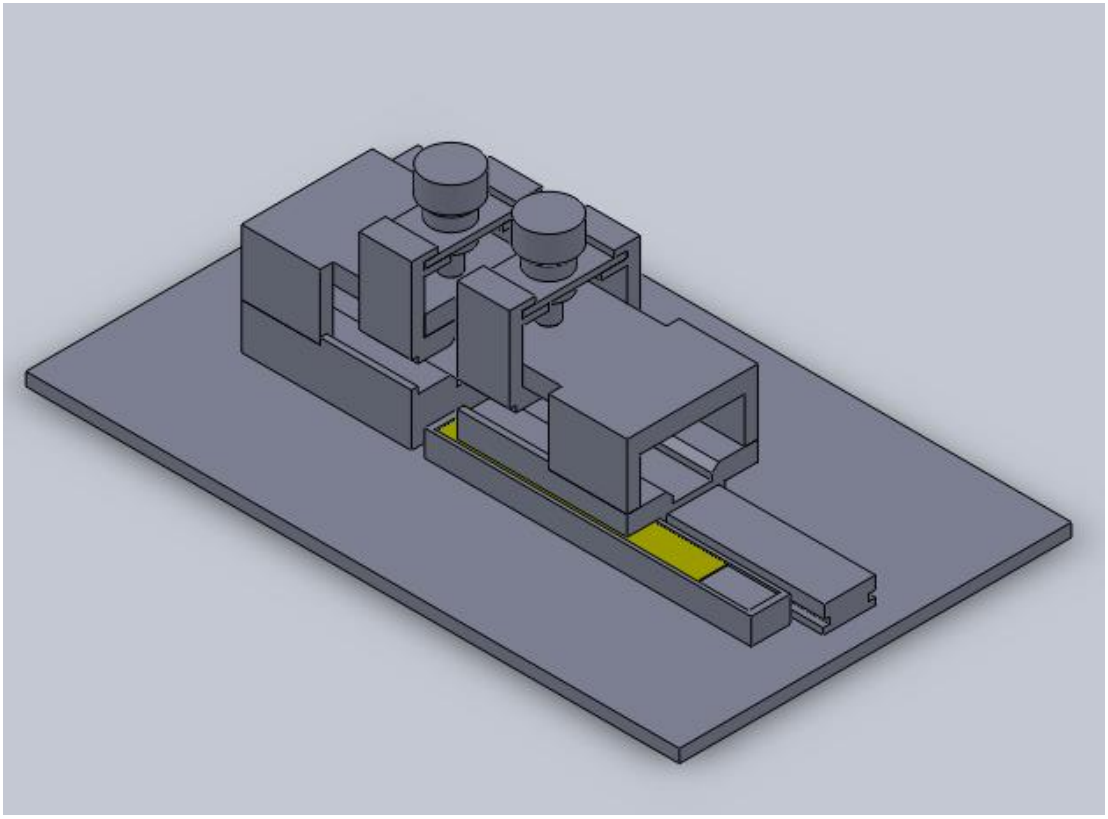
2) **Books References**
   a) P.H. Joshi. 2003. *Jigs and Fixtures Design Manual*. Robert O. Parmley. United State of America: McGraw-Hill Companies, Inc.
   b) K Venkataraman. 2005. *Design of Jigs, Fixtures & Press Tools.* India: Tata McGraw-Hill Publishing Company Limited.
   c) Mikell P. Groover. 2011. *Principles of Modern Manufacturing*. 4th edition. Asia. John Wiley & Sons (Asia) Pte Ltd.

APPENDIX

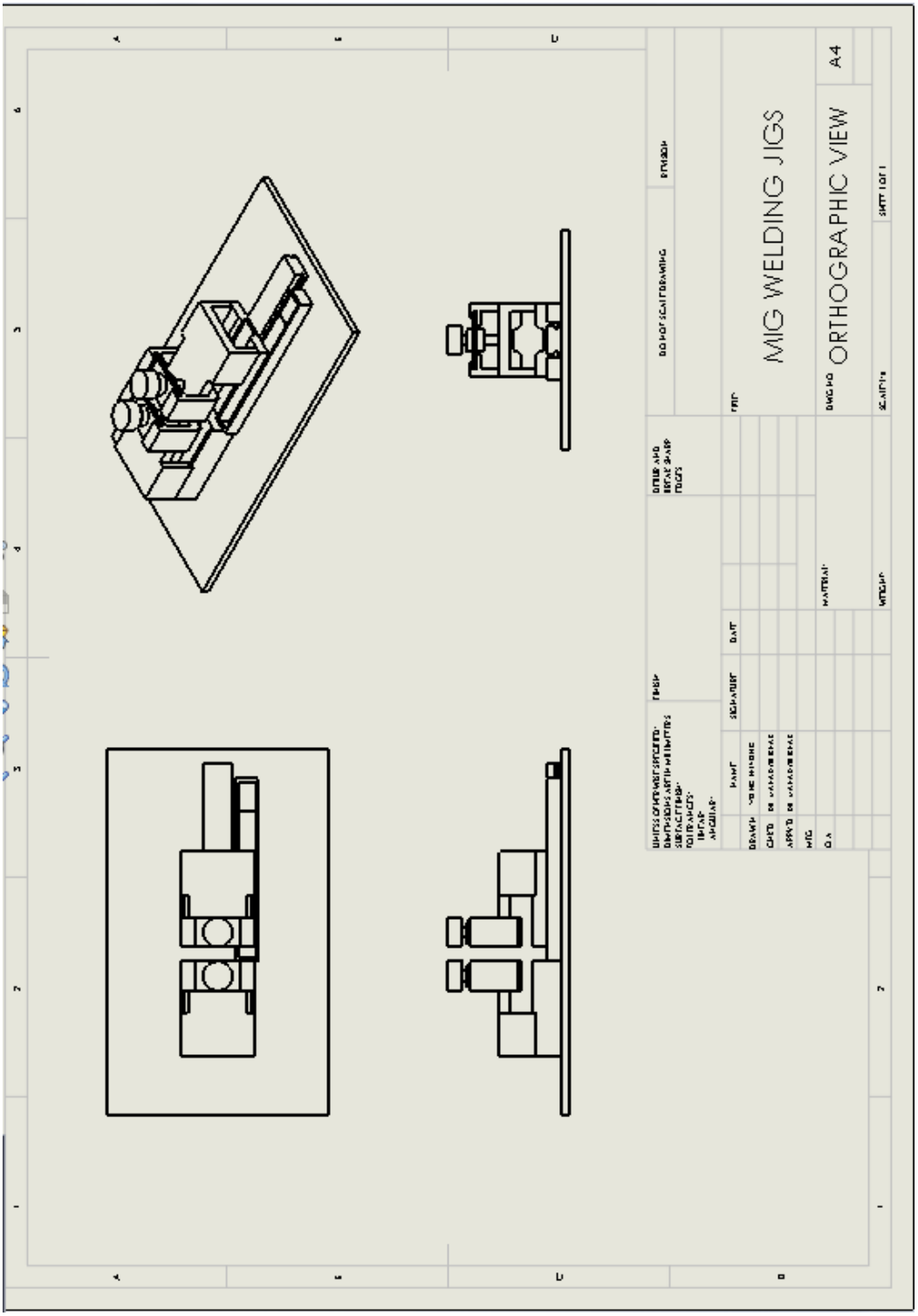
APPENDIX A

3D DRAWING OF THE MIG WELDING JIGS



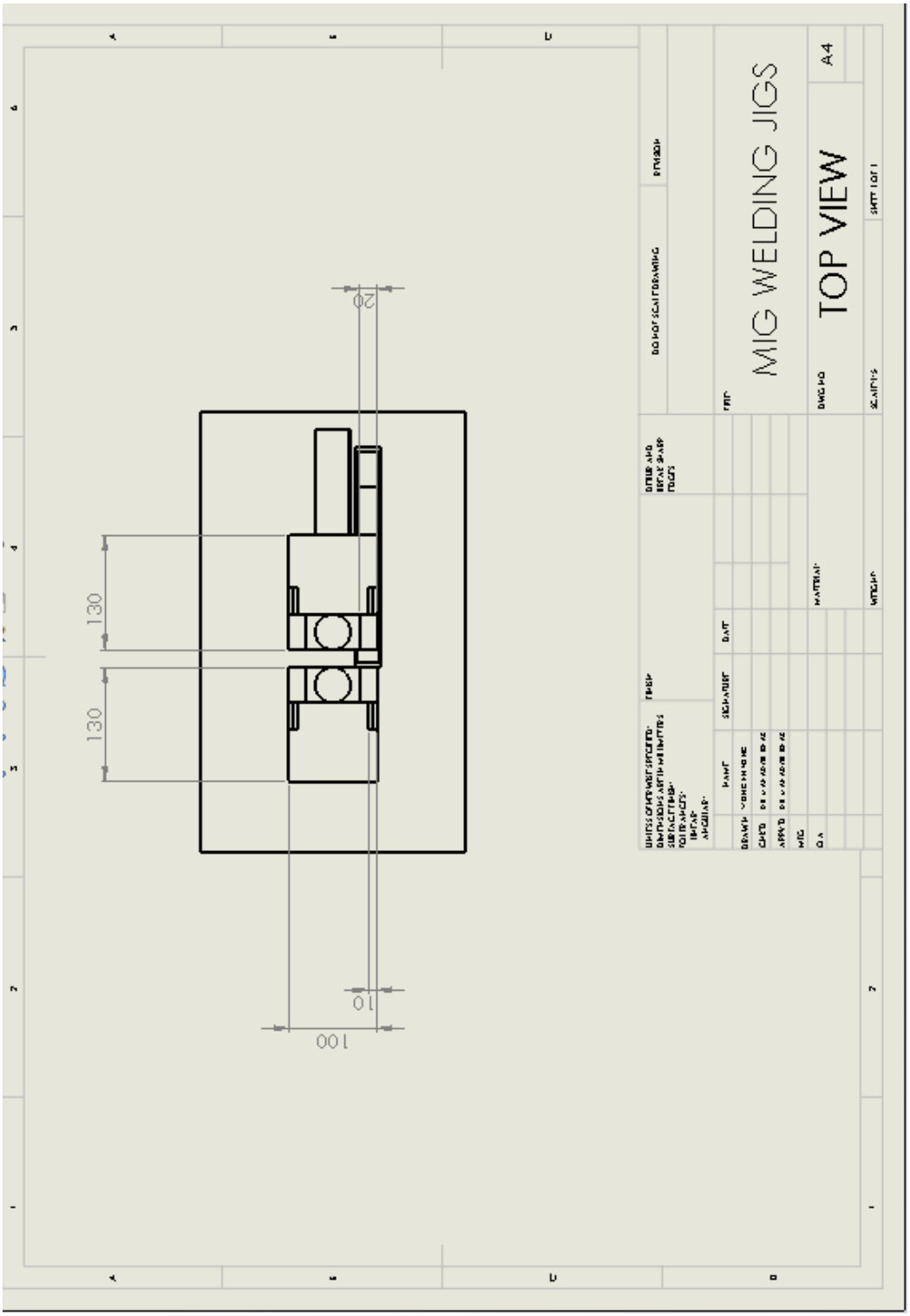
APPENDIX B

ORTHOGRAPHIC DRAWING OF THE MIG WELDING JIGS



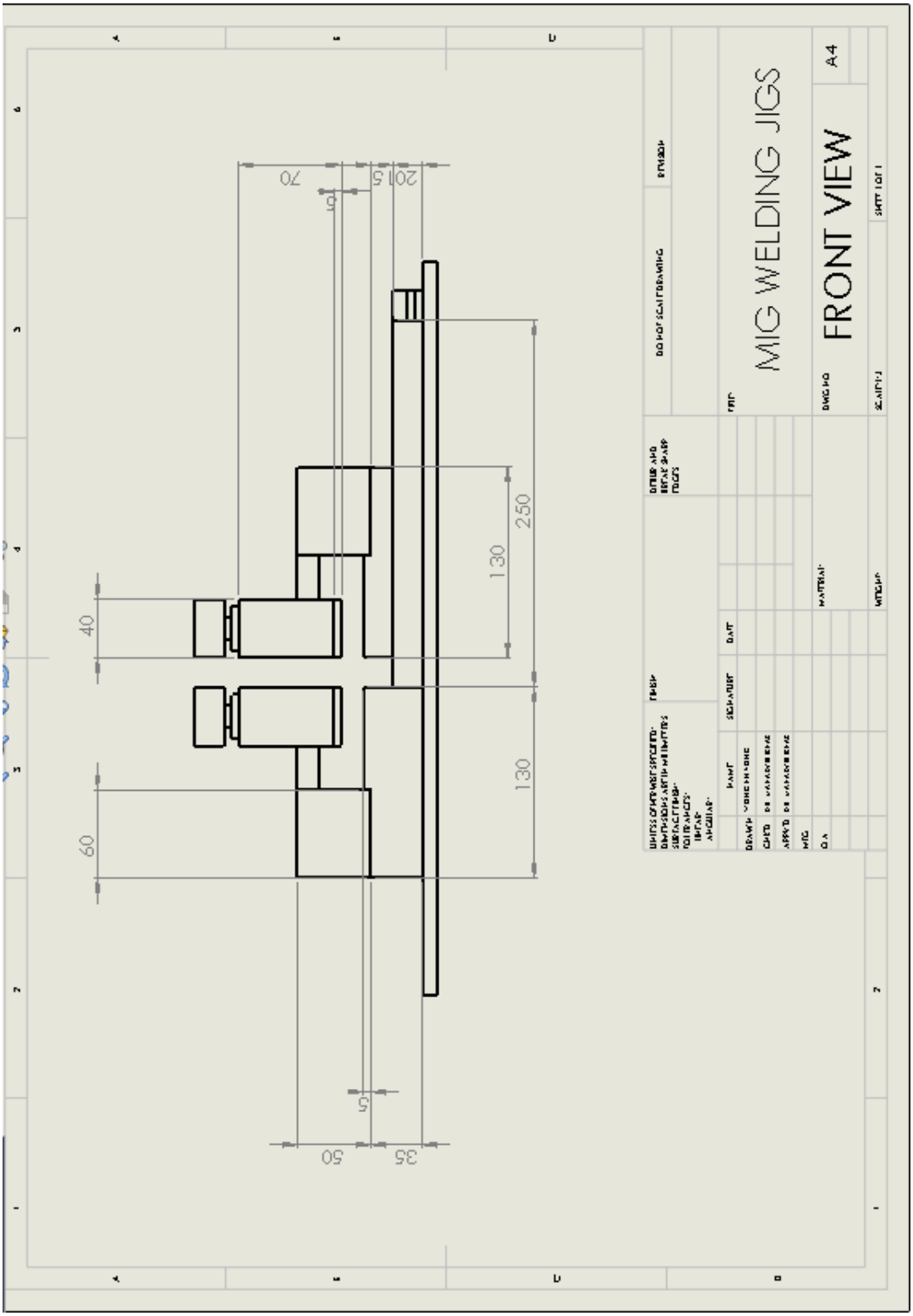
APPENDIX C

ORTHOGRAPHIC DRAWING (TOP VIEW)



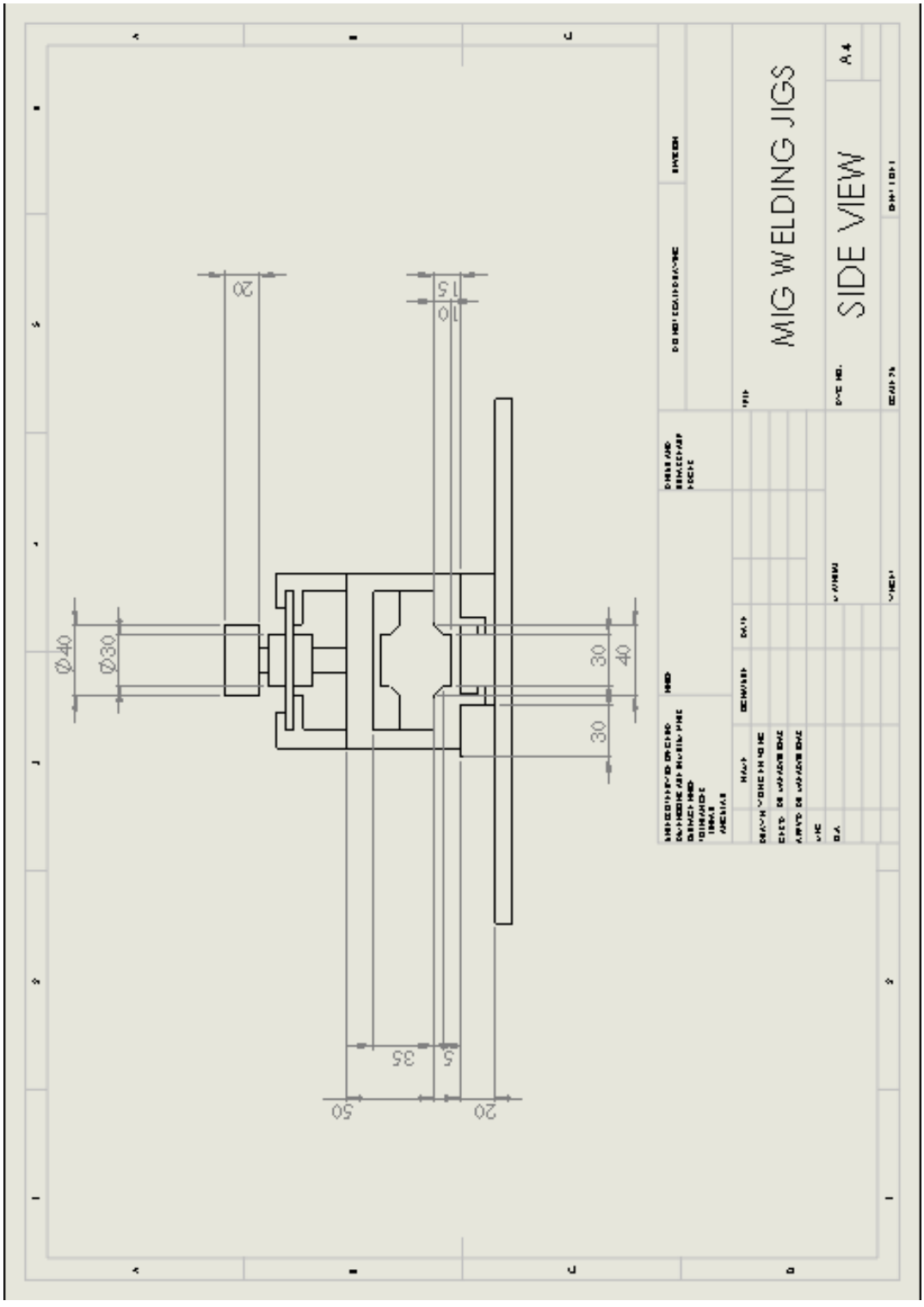
APPENDIX D

ORTHOGRAPHIC DRAWING (FRONT VIEW)



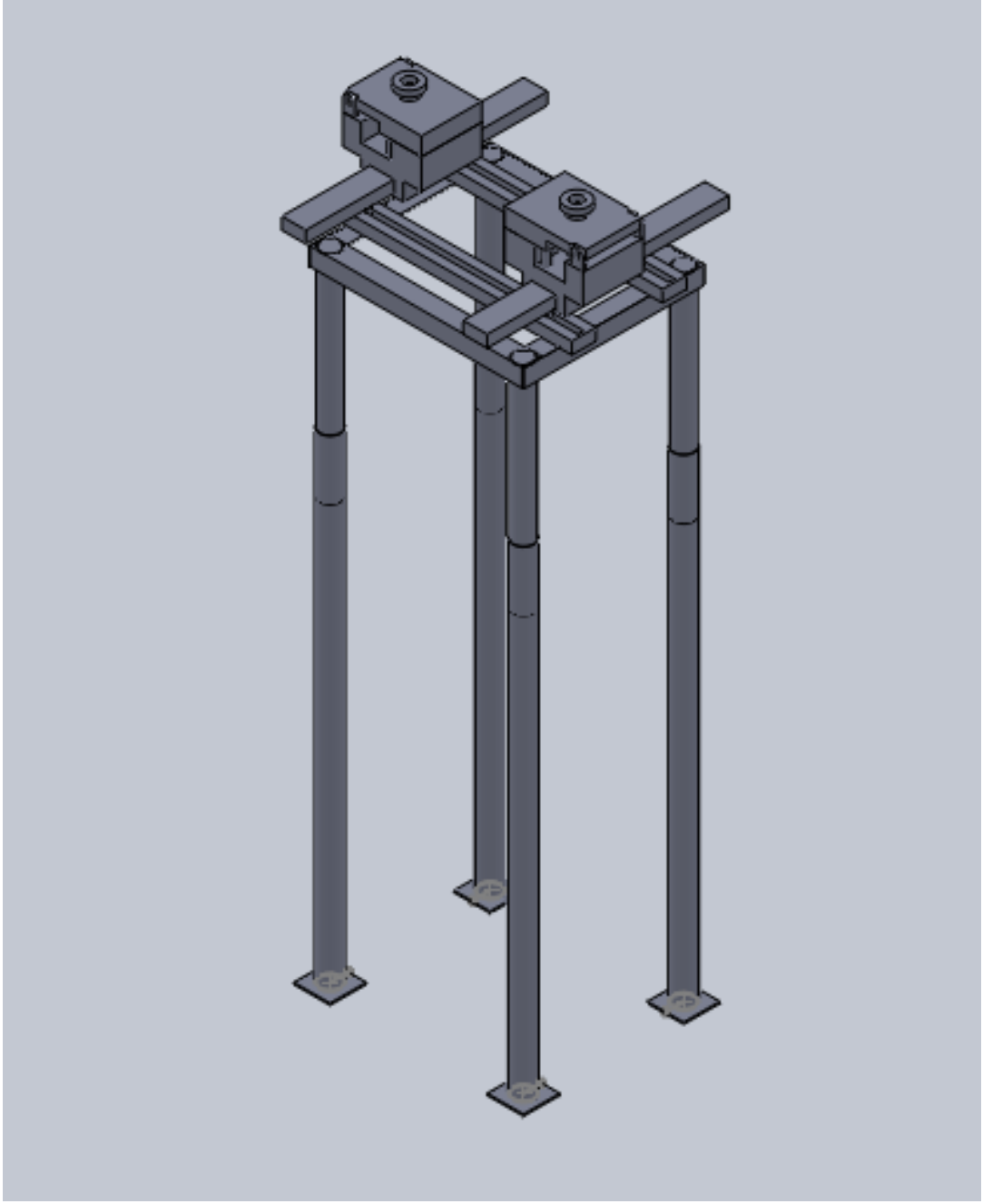
APPENDIX E

ORTHOGRAPHIC DRAWING (SIDE VIEW)



APPENDIX F

3D DRAWING OF RESISTANCE SPOT WELDING JIGS



APPENDIX G

ORTHOGRAPHIC DRAWING OF RESISTANCE SPOT WELDING JIGS