CONSTRUCTION AND PERFORMANCE TEST OF A SPOT WELDING MACHINE

A Thesis
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Of

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LETTER OF TRANSMITTAL

13 January, 2025

To

Shahinur Rahman

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Sonargaon University

Subject: Submission of Project Report**.**

Dear Sir,

We are pleased to submit the project report on **"Construction and Performance Test of A Spot Welding Machine".** It was a great pleasure to work on such an important topic. This project has been done as per instruction of your supervision and according to the requirements of the Sonargaon University.

We expect that the project will be accepted by the concerned authority we will remain happy to further explanation that you may feel necessary in this regard.

Thank You

Sincerely yours,

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DECLARATION

We do hereby solemnly declare that, the work presented here in this project report has been carried out by us and has not been previously submitted to any University/ Organization for award of any degree or certificate

We hereby ensure that the works that has been prevented here does not breach any existing copyright.

We further undertake to indemnify the university against any loss or damage arising from breach of the foregoing obligation.

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ABSTRACT

Spot welding is a widely used technique in manufacturing industries for joining metal sheets by applying heat and pressure at specific points. The spot welding machine utilizes electrodes to deliver an electric current to the metal sheets, generating heat through electrical resistance. This localized heating melts the metal, forming a strong, durable bond upon cooling. The process is efficient, cost-effective, and suitable for high-volume production, making it ideal for applications in automotive, aerospace, and appliance industries.Modern spot welding machines are equipped with advanced features such as precise control systems, programmable parameters, and real-time monitoring to ensure consistent weld quality. They are compatible with a variety of materials, including steel, aluminum, and other alloys, and offer benefits such as minimal material deformation and reduced energy consumption. This technology continues to evolve, integrating robotics and automation to enhance productivity and adaptability in diverse industrial applications.

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CHAPTER 1
INTRODUCTION

1.1 Introduction

Spot welding is a crucial process in manufacturing, enabling the efficient joining of metal sheets through the application of heat and pressure at specific points. This project focuses on the design and development of a spot welding machine, a key tool in industries such as automotive, aerospace, and electronics, where high-speed, reliable, and cost-effective metal joining is essential.The spot welding machine operates on the principle of electrical resistance heating. When an electric current flows through the metal sheets held between two electrodes, resistance at the contact points generates heat, causing the material to melt and fuse together upon cooling. This localized heating ensures minimal distortion to the surrounding material, preserving its structural integrity.

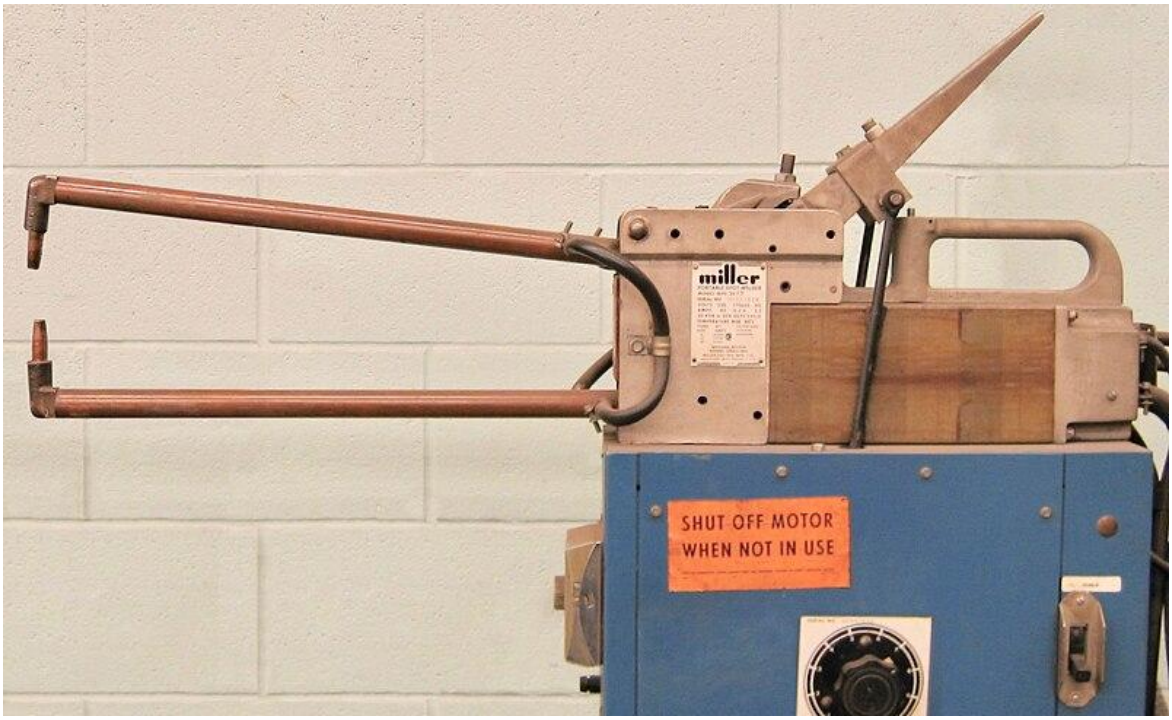


Figure 1.1 Spot Welding

This project emphasizes creating a machine with advanced features for improved performance and adaptability. The system incorporates precise control mechanisms, programmable welding parameters, and real-time monitoring to ensure consistent weld quality and operational efficiency. It is designed to handle a wide range of materials, including steel, aluminum, and other alloys, catering to diverse industrial

requirements.Additionally, the project explores the integration of automation and robotics to enhance productivity and versatility. By leveraging modern technologies, this spot welding machine aims to meet the demands of high-volume production while maintaining energy efficiency and reducing operational costs. The outcome of this project will provide an innovative and sustainable solution, contributing to advancements in manufacturing processes and fostering industrial growth.

1.2 Background Study

In earlier studies, researchers have found the possibility of nugget growth mechanism analysis and weld quality calculation by various methods. Destructive test method was the commonly used method for spot weld quality, which was widely used in macro structure or micro structure observation and mechanical characteristic testing . Because of it's low efficiency and results in the invalidation of product, the non destructive test is necessary in manufacture. Engineers toward quality evaluation of spot welds have developed various non destructive test methods such as ultrasonic testing and ultrasonic C-scan detection . All these are off-line test methods and still problematic in test efficiency. Currently, weld quality test on the basis of on-line technology are proposed, which can provide basis for technological development of non destructively test.

Heating of electrode is also a factor which has deep impact on the quality of the weld. During manufacturing of electrode materials and their operation, one tries to have a long electrode life. The electrode life, i.e. the number of welds produced depends on various factors which affects the behaviour of electrode material in not stabilised thermal conditions, with on-going recrystallisation and ageing. The most important factors affecting electrode life include:

1) Chemical composition of an alloy used in the electrode and thermo-mechanical treatment affecting the structure, alloy hardness, softening temperature and electric conductivity.

2) Settings of welding parameters (pressure force, value and time of welding current) depending on the type/grade and thickness of a material being welded,

3) Shape and working diameter of an electrode, heating temperature of the working area, electrode cooling medium and its flow rate, welding rate.

The impact of the above said factors on electrode life has been a subject of numerous researched works . Thus the electrodes are one of more important elements of a welding process, the impact of an electrode shape on the process of welding has been a subject of research . Many researchers mainly had focused on distribution of temperature in welding area . Researchers revealed that the use of numerical computational models could save time and reduce costs while developing new welding technologies . Also, weld nugget size and welding residual stresses are two important parameters determining the mechanical behaviour of the spot weld joints. The residual stresses in welded parts could decrease fatigue and fracture strength of structures. This indicate that through selection of appropriate parameters, desired nugget sizes and minimum welding residual stresses could be achieved . Also besides influencing the electrical resistance, electrode force imposes pressure on the weld zone during heating and cooling, and it affects the residual stresses, the welding time and current, electrode diameter, materials, pre-heating, post-heating cycles, and work piece thickness are other effective parameters . Moreover a systematic approach from safety point of view was followed as per the research studies carried out by Irfan at all.

1.3 Problem Statement

Spot welding is a critical process in manufacturing, used extensively in automotive, electronics, and metal fabrication industries. However, traditional spot welding machines face several limitations that hinder efficiency, precision, and product quality. Inconsistent weld strength due to inadequate control of parameters such as current, pressure, and weld time often leads to defective joints, compromising the structural integrity of the final product. Manual operation and outdated monitoring systems further contribute to operational inefficiencies, increased production downtime, and higher rejection rates.

Another significant challenge is the inability to adapt to different materials and varying thicknesses, which is essential in modern manufacturing. Overheating and electrode wear due to improper heat regulation result in frequent maintenance and reduced machine lifespan. Energy inefficiency and lack of real-time data analytics further exacerbate operational costs and limit scalability in high-volume production environments.

To address these challenges, a smart spot welding machine integrating advanced automation, real-time monitoring, and adaptive control is essential. Such a system can optimize weld parameters, ensure consistent quality, and provide predictive maintenance alerts. This approach not only enhances productivity and reduces waste but also aligns with Industry 4.0 principles by leveraging IoT and data-driven insights for improved decision-making and operational efficiency.

1.4 Motivation

The motivation for this project stems from the growing need for efficient, reliable, and sustainable manufacturing solutions in the modern industrial landscape. Spot welding machines are vital in industries like automotive, electronics, and construction, yet many existing systems face challenges that hinder their performance and scalability.Inconsistent weld quality, high energy consumption, and limited adaptability to diverse materials not only increase production costs but also compromise product reliability. These limitations are further exacerbated by the lack of real-time monitoring and advanced control systems, which are essential for minimizing defects and maximizing productivity.

The rapid advancement of Industry 4.0 technologies offers a unique opportunity to address these challenges. By integrating real-time sensors, adaptive control algorithms, and energy-efficient designs into spot welding machines, manufacturers can achieve consistent quality, reduce downtime, and enhance operational efficiency.This project is driven by a vision to revolutionize traditional spot welding systems by incorporating smart features that align with sustainability goals and the demand for automation in modern factories. It aims to empower industries with innovative, future-ready solutions, ultimately fostering growth, reducing environmental impact, and strengthening global competitiveness.

1.5 Objectives

We have some specific objectives for this project and they are pointed below:

- To Construct of a **Spot Welding Machine.**
- To implement and study of **Spot Welding Machine.**
- To take necessary notes from the project for future improvements.

1.6 Structure of the Project

This Project is organized as follows:

Chapter 1 Introduction: The first chapter contains the statement of the introduction, problem statement, objectives of the study and the project outline.

Chapter 2 Literature Review: The chapter two contains our introduction, literature review part.

Chapter 3 Hardware and Software Analysis: Chapter three describes the theoretical model. Here we mainly discuss about proposed system Hardware and software development of our project etc.

Chapter 4 Methodology: Chapter three describes the theoretical model. Here we mainly discuss about proposed system architecture in details with having block diagram, circuit diagram, structural diagram, project working principle, complete project image etc.

Chapter 5 Result and Discussion: Chapter four deals with the result and discussion and discuss about our project advantages and application.

Chapter 6 Conclusion: Chapter five all about our project conclusion and future scope.

CHAPTER 2
LITERATURE REVIEW

2.1 Introduction

This chapter is arranged on Literature Review. Here's a look at some of last year's literature, like our project. By reading them, we can overcome the mistakes of the previous project and make a more effective project.

2.2 Related Research/ Works

Resistance spot welding of AISI 430 stainless steel (ferritic) was performed to observe the phase change. Based on the physical metallurgy technology of ferritic stainless steel welding, the phase transformation during the welding thermal cycle is analyzed in detail. It was found that the fusion zone micro structure and the HAZ were affected by different phenomena such as grain growth, carbide precipitation and martensite formation [1].

The welding time effect of the mechanical properties of automotive sheet in resistance spot welding was studied. In this study, a series of chromided alloyed steel was used and joined by RSW with fixed electrode formats, material types, electrode force, cooling water flow and also by varying welding time and current. All series were tested for tensile peel and tensile shear to determine joint strength. At a welding current of 10 kA, the maximum tensile shear strength values of galvanized chromate steel sheet resistance spot welds were obtained for 12 and 15 cycle weld times. At 12kA welding current for 15 cycles, the indentation depth of the electrode on the work piece is about 15% of the plate thickness. It has been suggested that the above situation is suitable in order to obtain the maximum tensile shear strength. When there is a requirement of surface quality, two methods are effective. One is a 10kA welding current for 10 cycles and the other is a 9kA welding current for 12 cycles. The indentation depth of the electrode into the work piece is 8% of the sheet thickness. These are below the 20% limit to get a good surface. Maximum tensile peel strength values of spot welded chromate steel sheet for 10-time weld time at a welding current of 11 kA. Again, the indentation depth of the electrode into the work piece is 8% of the sheet thickness. These values are below 20% of the steel thickness to achieve surface quality [2].

Resistance spot welding was performed on dual phase steel and the softening of the base metal (BM) and the heataffected zone (HAZ) was evaluated by a nano indentation hardness test. Along sub-critical HAZs, at different distances from the lower critical temperature line by ferrite and tempered martensite (TM) has been investigated. The SEM observations are consistent with the results of the nano-hardness of the TM phase along the sub-critical HAZ. In contrast, the results of micro hardness show that the tempering distance is shorter relative to Ac1 and therefore reduced extension in the softening region. Improved resolution of the softening assessed by nano-indentation is due to the fact that the size of the indentation can avoid the contribution of the phase boundary and also allows for the evaluation of TM at low temperatures far from Ac1, at which early stage occurs [3].

Ultimate strength behavior of mild steel subjected to combined shear and tension load are investigated. All tests indicate that fracture in the heat affected zone developed shortly after the metal sheet yielded. Moreover, the load carrying capacity of a single resistance spot weld is reduced as the loading angle increases, with approximately a 20% strength reduction from 0° to 90° angles. The tensile strength of a resistance spot weld in mild steel was found to be equal to 80% of the shear strength. The analysis of variance technique was used to investigate the effect of coupon length, coupon width, and nugget diameter on the ultimate strength of the welded coupon. The analysis shows that the nugget diameter and the coupon width are the only two significant factors in the experiment with 99% confidence level and that the nugget diameter contributes more than 70% to the total variation of the test data [4]

The microstructure and failure behavior of different resistance spot welds on low-carbon galvanized and austenitic stainless steels were investigated. It was observed that the strength of spot weld under drawing failure mode is controlled by the strength of the galvanized steel side and the size of the melting zone. The hardness of the fusion zone controlled by the dilution between the two parent metals and the fusion zone size of the galvanized carbon steel side is controlled by failure mode. For spot welding at low welding current, low zone hardness and small zone size lead to an interface mode during shear tensile test. Despite the higher fusion zone hardness due to the formation of martensite and the larger melting zone when spot welding is performed at high welding current, the drawing failure mode occurs during the tensile shear test [5].

The effect of welding current on mechanical properties of resistance spot welded chromided steel was investigated. In the connection of galvanized chromate steel plates, the maximum tensile shear strength is obtained in 15 cycles at a welding current of 10 kA. Since the electrode indentation in the material to a depth of 15% of the sheet thickness and did not exceed 20% of the sheet thickness limit of good surface quality. When the surface quality is higher than the strength, a welding current of 10 kA at 10 cycles of welding time or 9 kA of welding current at 12 cycles of welding time is sufficient. Of these suggested values, the depth of the electrode indentation is 8% of the sheet thickness and does not exceed the limit of 20%. In the bonding of the galvanized chromate steel sheet, the maximum tensile peel strength was obtained when 10 cycles were performed at a welding current of 11 kA. This value is about half the tensile shear strength, indicating the sensitivity of the galvanized chromate sheet welded by RSW to the tensile peel test. This application area recommends 10 cycles of welding current (11kA) because the depth of the electrode indentation in the material is 8% of sheet thickness and does not exceed the allowable 20% limit of surface quality [6].

Resistance spot welding was conducted on titanium sheets with dissimilar welding parameters to evaluate the joint strength. Tensile shear tests were carried out on welded joints to find out the strength of the weld zone. In addition, in order to check the influence of welding parameters on the welded joint, hardness and microstructure examination were performed. The results show that increasing the current time and the electrode force increases the tensile shear strength and the joint obtained with argon atmosphere has better tensile shear strength. Hardness measurements show that the weld nugget has the highest hardness, as is the heat affected zone (HAZ) and the base metal. Argon used in the welding process is considered to have no effect on the hardness value. Microscopic examination revealed that the weld deformation occurred during the welding process. Twinning occur in grains, the use of high electrode force and high welding cycles during welding increases twinning [7].

The welding test of 17-4PH type precipitation hardened steel is carried out. The possibility of joining centrifugal compressor impeller components as important elements of a turbo machine is considered. High tensile strength and high corrosion resistance are achieved after aging at 893 K/2 h at 1313 K/2 h, or after 893 K/2 h after welding. For centrifugal compressor impeller applications, the use of filter material for 17-4PH steel welding is

very effective. 17-4PH steel welded joints have good corrosion resistance. The corrosion occurring in the HAZ mainly has pitting characteristics and the weld with excellent resistance. Lower aging temperature will improve the mechanical properties and hardness, but will reduce the corrosion resistance of welded joints. Aging temperatures above 893K ensure enhanced corrosion resistance. The excellent mechanical properties of the joints provide heat treatment conditions C which is saturated at 1313 K/2 h and aged 893 K/2 h). The joint in heat treatment condition C has the best corrosion resistance to the core wire. Annealing A (893 K/2 h) weld joints to ensure similar mechanical properties, such as heat treatment [8].

P. Sathiya, K. Panneerselvam, R. Soundararajan [9] showed that Laser welding input parameters play a very significant role in determining the quality of a weld joint. The joint quality can be defined in terms of properties such as weld bead geometry, mechanical properties and distortion. Therefore, mechanical properties should be controlled to obtain good welded joints. In this study, the weld bead geometry such as depth of penetration (DP), bead width (BW) and tensile strength (TS) of the laser welded butt joints made of AISI 904L super austenitic stainless steel were investigated. Full factorial design was used to carry out the experimental design. Artificial Neural networks (ANN) program was developed in MatLab software to establish the relationships between the laser welding input parameters like beam power, travel speed and focal position and the three responses DP, BW and TS in three different shielding gases (Argon, Helium and Nitrogen). The established models were used for optimizing the process parameters using Genetic Algorithm (GA). The developed ANN model is suitably integrated with optimizing algorithms like GA to optimize the welding parameters. For the optimized welding parameters of GA, the laser welding joints were processed. Joints exhibit better quality. The good agreement between the theoretically predicted (GA) and experimentally obtained tensile strength, depth of penetration and bead width confirms the applicability of these evolutionary computational techniques for optimization of process parameters in the welding process.

G. R. Mirshekari, A.Saatchi, A.Kermanpur, S.K.Sadrnezhaad [10] have shown in their work a comparative study on laser welding of NiTi wire to itself and to AISI304 austenitic stainless steel wire . Microstructures, mechanical properties and fracture morphologies of the laser joints were investigated using optical microscopy, scanning

electron microscopy (SEM), energy dispersive spectroscopy (EDS), X-ray diffraction analysis (XRD), Vickers micro hardness (HV0.2) and tensile testing techniques. The results showed that the NiTi–NiTi laser joint reached about 63% of the ultimate tensile strength of the as-received NiTi wire (i.e.835MPa) with rupture strain of about 16%.This joint also enabled the possibility to benefit from the pseudo-elastic properties of the NiTi component. However, tensile strength and ductility decreased significantly after dissimilar laser welding of NiTi to stainless steel due to the formation of brittle intermetallic compounds in the weld zone during laser welding. The micro hardness values from the weld zone toward the base metal increased in NiTi–NiTi joint, while it decreased in NiTi–SS joint. In addition, NiTi – NiTi joint was fractured in ductile manner at the weld zone near the fusion line, while brittle failure occurred at the center of the NiTi–SS weld zone.

Lifang Mei, Genyu Chen, Xiang zhong Jin, Yi Zhang, Qiang Wu [11] presented some useful results on deep-penetration laser welding of high-strength galvanized steel sheets, which had been carried out by a self-made CO2 laser unit with maximum power output of 1.5kW.The work pieces of high-strength galvanized automobile steels with thickness of 1.5mm were butt-welded with argon as the shielding gas. The effects of such factors as laser power, welding speed, focal position, shielding gas and zinc vaporization on the quality of welds are investigated. With the processing parameters optimized and the proper shielding gas used in both co axial and side-blow direction, most of the defects, such as pores, cracks and softening in HAZ, can be avoided in laser welding joints. The microstructure, the hardness distribution and the elemental distribution in the welding joints can be changed due to laser heating and recrystallization. In order to determine the mechanical properties of the welding joints, the static tensile strength was tested. Experimental results indicated that both the strength and micro hardness of welding joints were higher than those of the base metal. The deep punching performance acquired by adopting Ar as shielding gas is better than that acquired by adopting N2 as shielding gas .Meanwhile; the effect of zinc vaporization on welding joints can be effectively controlled by means of blowing side shielding gas. The experimental results indicate that the promising welding quality can be obtained under the chosen condition of taking Ar as shielding gas, laser power P as 1300W, defocusing amount Df as 0.4mm, welding speed v as 1.0 m/min, coaxial-blown shielding gas-flow rate q as 2.5 m 3 /h, side-blown shielding gas-flow rate q as 1.8 m 3 /h, and side-blown angle α as 301.

A. G. Olabi, F.O. Alsinani, A.A. Alabdulkarim, A. Ruggiero, L. Tricarico , K.Y. Benyounis [12] investigated dissimilar full-depth laser-butt welding of low carbon steel and austenitic steel AISI316 was investigated using CW 1.5kW CO2 laser. The effect of laser power, welding speed and focal point position on mechanical properties (i.e., ultimate tensile strength, UTS and impact strength, IS) and on the operating cost C was investigated using response surface methodology (RSM). The experimental plan was based on Box–Behnken design; linear and quadratic polynomial equations for predicting the mechanical properties were developed. The results indicate that the proposed models predict the responses adequately within the limits of welding parameters being used a laser power value of 1.1 kW is suggested as an optimum input process value to obtain excellent welded joints produced from austenitic stainless steel AISI316 and low carbon steel. The welding speed is the most effective parameter affecting the main weld bead dimensions as the area and the middle width, and it has to be set right on certain values to make all the responses optimized. Being focal point position fixed around -0.41 mm and laser power on 1.17 kW, setting welding speed on 72.66 cm/min, all the weld bead dimensions come out very reduced as area can be minimized by more 9% and middle width by 14%, spending 20% less money than the first criteria solution cost. Anyway, depending on the desired impact strength value for the specific application, if any, and on how much important and critical are mechanical properties on that, fixing welding speed on 57.93 cm/min, focal point position on -0.35 mm and laser power on 1.30kW, can be more efficient and smart, as it ensures a pretty higher value of ultimate tensile strength (360MPa) and impact strength (70.44J).

Shanmugarajan B., Chary J N. , Padmanabham G., Arivazhagan B. , Shaju K. Albert , Bhaduri A.K. [13] studied Influence of variables such as laser power, welding speed, shielding gas and laser beam mode on microstructure and mechanical properties. Here autogenously bead-on-plate (BoP) laser welding studies were carried out on 3mm thick 304B4 grade stainless steel using a 3.5kW slab CO2 laser. Dye penetrant testing, microstructural analysis, bead geometry measurements, micro hardness survey, and micro structural analysis in both as-weld and post-weld heat treated conditions were carried out. The microstructural and bead geometry analyses of the welds have shown that the welds were free from cracks in the fusion zone (FZ) and also in the heat affected zone (HAZ) for all the welding parameters studied. The Gaussian mode has given a very narrow weld width compared to donut mode. During welding use of helium and nitrogen has reduced

the width of the FZ and HAZ. The as-weld micro hardness was more than double the base metal, and the peak hardness was shifted from the center to the fusion boundaries with the increase in heat input. The PWHT has reduced the hardness of both the FZ and HAZ.

Mingjun Zhang, Genyu Chen , Yu Zhou, Shenghui Liao [14] examined the effect of the processing parameters on the weld bead geometry and the microstructure and mechanical properties of the optimal joint were investigated. The results show that the focal position is a key parameter in high-power fiber laser welding of thick plates. There is a critical range of welding speed for achieving good full penetration joint. The type of top shielding gas influences the weld depth. The application of a bottom shielding gas improves the stability of the entire welding process and yields good weld appearances at both the top and bottom surfaces. The maximum tensile stress of the joint is 809 MPa. The joint fails at the base metal far from the weld seam with a typical cup–cone-shaped fracture surface. Welding speed, Focal position and shielding gas are the parameters that are studied. The weld depth increases when a top shielding gas is applied in the following order: argon < nitrogen < helium. The application of a bottom shielding gas improves the stability of the entire welding process, yielding good weld appearances at both the top and bottom surfaces.

A. Squillace, U. Prisco, S. Ciliberto, A. Astarita [15] studied the influence of welding speed and laser power on weld quality of 1.6 mm thick Ti − 6Al − 4V sheets autogenously laser beam welded in butt configuration using a Nd-YAG laser. The joint quality was characterized in terms of weld morphology, microstructure and mechanical properties. An under fill defect, controlling the whole weld geometry, was observed both at the weld face and root surface. In dependence of the specific heat input, this defect showed a maximum, which separates two different welding regimes: keyhole welding, at low heat input, and a welding regime where heat conduction around the keyhole is predominant, at high heat input. Influence of the under fill radius on the weld fatigue life was also assessed. Weld morphology is strictly influenced by the welding regime wherein they are produced. The welds under investigation, compared with the base material, reach similar tensile performance with a reduced ductility. Fatigue life of the investigated welds is strongly influenced by the value of the under fill radius. Indeed, the S–N curve tends to move towards region of higher cycles as the value of the under fill radius increases; this means that the fatigue strength of the welded joints can be improved by partially or

totally eliminating the under fill. The fatigue fracture initiates and propagates near the lower point of the under fill convexity at the interface between the FZ and the HAZ.

2.3 Summary

The above has been discussed in detail in the past few literature's which has given us a lot of motivation to do this project.

CHAPTER 3
HARDWARE AND SOFTWARE ANALYSIS

3.1 Introduction

In this section, we will discuss elaborately about our hardware design of " **Construction and Performance Test of Spot Welding Machine**" and the component description, features, working procedure and description of our all equipment.

Software

- Easy EDA

Hardware

- Transformer
- Exhaust Fan
- Switch

3.2 Transformer

A transformer is an electrical device used to change the value of an alternating voltage. Transformers are widely used in electrical work. They are encountered daily, in industrial, commercial and domestic situations. They vary in size from miniature units used in electronics to huge units used in power stations. The efficient transmission and distribution of electricity throughout the country would be impossible without the use of power transformers. Center Tapped Step Down Transformer is a general purpose chassis mounting mains transformer. Transformer has 230V primary winding and center tapped secondary winding. The transformer has flying colored insulated connecting leads (Approx 100 mm long). The Transformer act as step down transformer reducing AC - 230V to AC - 12V. The Transformer gives outputs of 12V, 12V and 0V.

The Transformer's construction is written below with details of Solid Core and Winding. The transformer is a static electrical device that transfers energy by inductive coupling between its winding circuits. A varying current in the primary winding creates a varying magnetic flux in the transformer's core and thus a varying magnetic flux through the secondary winding. This varying magnetic flux induces a varying electromotive force

(E.M.F) or voltage in the secondary winding. The transformer has cores made of high permeability silicon steel. The steel has a permeability many times that of free space and the core thus serves to greatly reduce the magnetizing current and confine the flux to a path which closely couples the winding.



Figure 3.1: Transformer

Full Wave Bridge Rectifier

This type of single phase rectifier uses four individual rectifying diodes connected in a closed loop “bridge” configuration to produce the desired output.The main advantage of this bridge circuit is that it does not require a special centre tapped transformer, thereby reducing its size and cost. The single secondary winding is connected to one side of the diode bridge network and the load to the other side as shown below. The filtered full wave rectifier is created from the FWR by adding a capacitor across the output.

The four diodes label led D1 to D4 are arranged in “series pairs” with only two diodes conducting current during each half cycle. During the positive half cycle of the supply, diodes D1 and D2 conduct in series while diodes D3 and D4 are reverse biased and the current flows through the load as shown below.

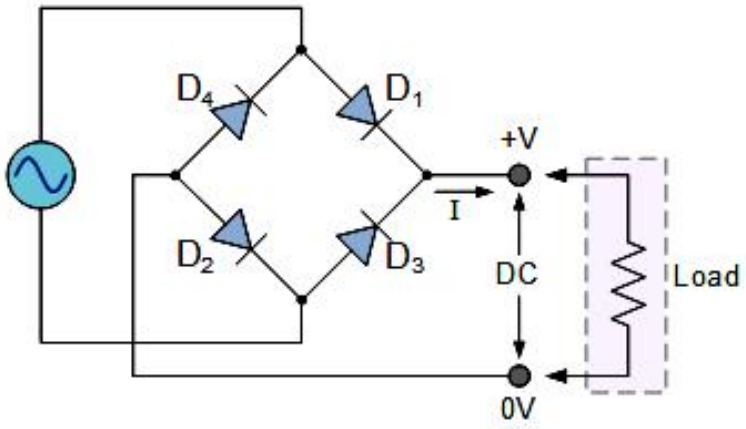


Figure 3.2: Full Wave Bridge Rectifier

The Positive half Cycle: During the negative half cycle of the supply, diodes D3 and D4 conduct in series, but diodes D1 and D2 switch “OFF” as they are now reverse biased. The current flowing through the load is the same direction as before.

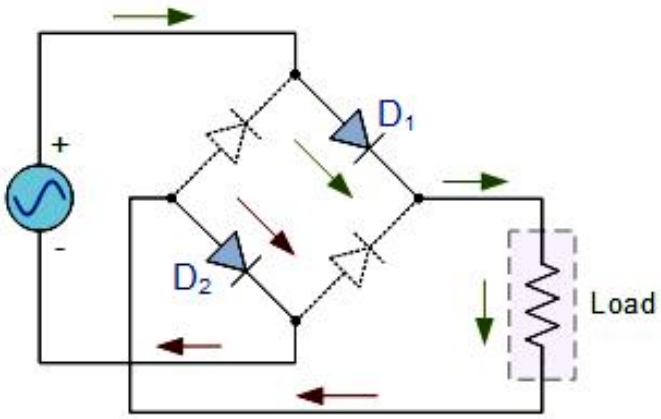


Figure 3.3: Positive Half Cycle of Full Wave Bridge Rectifier

3.3 Exhaust Fan

Exhaust fans are **used to pull excess moisture and unwanted odors out of a particular room or area**. They are commonly found in bathrooms and kitchens, where moisture can build up due to activities such as showering, washing, or cooking. The existence of clean air in the house is something that every homeowner must pay attention to. As is known, dirty air trapped in the house can cause various diseases, especially respiratory diseases for all family members. Because of that, every house must have a good air circulation system by installing ventilation. As for people who live in urban areas, often the presence of ventilation is not enough to replace the air in the house.



Figure 3.4: AC Exhaust Fan

Exhaust fans are a solution so that the exchange of clean air and dirty air in the house can run well. Sometimes homeowners can install more than 1 exhaust fan in the house. Usually the rooms where the exhaust fan is installed are the bathroom and kitchen or places with poor air circulation. There are various types of exhaust fans available in the market. Just adjust it to the needs and benefits you want to get. Even so, it turns out that the exhaust fan has its own advantages and disadvantages.

Exhaust Fan Advantages

The existence of an exhaust fan provides many advantages, especially if it is installed in a room with poor air circulation. The advantages of exhaust fans include:

1. Improve Indoor Air Quality

Exhaust fans installed in rooms such as bathrooms or kitchens can help improve air quality to be cleaner. Stuffy air like in the bathroom to the smell of cooking that is too strong can be replaced immediately if there is an exhaust fan in the room.

2. Eliminate Bad Smell

The unpleasant and pungent smell is very disturbing. Especially if the aroma comes from a room with a poor air exchange system such as in the bathroom. This makes people think that the room is very dirty and makes people reluctant to enter it. For this reason, the installation of an exhaust fan is necessary to reduce or eliminate unpleasant odors in the room. That way the air in the room remains clean and does not smell when entering the room.

3. Removes Air Moisture

A humid room makes the air stuffy and smelly. If left unchecked, it is not impossible to damage the walls and ceiling of the house because it is too wet. Even in certain parts can be overgrown with moss and fungus which of course can damage a room. For this reason, the installation of an exhaust fan is very useful to quickly remove moisture from the air. That way the air in the room remains dry and not too humid because of good air exchange by the exhaust fan. Installing an exhaust fan in the bathroom can also help eliminate foggy mirror syndrome due to too high humidity.

4. Reduce Air Contamination

Cooking smoke, cigarette smoke, hot air, and unpleasant odors are very disturbing to the human respiratory system. Especially if the air is dangerous and causes a disease if inhaled for a long time. For this reason, the existence of clean air must always be available in the house in order to provide comfort for every family member. Removing contaminated and dirty air does not need to open all windows and doors of the house, just use an exhaust fan. Because the change of air becomes faster and easier if you use an exhaust fan.

5. Can Be Used as an Air Conditioner

Exhaust fans can also cool the air in the room. This is in accordance with the working principle of the exhaust fan, which is to absorb hot air in the room to the outside, then replace it with new air so that the room becomes cooler.

At first glance, the way it works is similar to a fan, but it is more efficient at dissipating heat in the room.

Disadvantages of Exhaust Fan

Behind the advantages, it turns out that the exhaust fan also has several disadvantages, including:

- Almost all exhaust fans sold on the market use electricity in the form of electricity, so that in the event of a power outage, of course the exhaust fan cannot work.
- Some types of exhaust fans must be installed in the wall or even become one with the ceiling of the house or ceiling. In other words, the exhaust fan cannot be moved anywhere.

- If the installation is not done properly, there is a possibility that hot and humid air can escape to other areas in the house. Not only that, an exhaust fan that is not properly insulated, when air is drawn from the interior, can be lost in the attic of the house and can actually cause another problem such as damp tiles.
- Improper installation of the exhaust fan can make a noise when the fan rotates. The sound produced is very disturbing to the occupants of the house, so it is very likely that the exhaust fan will not be operated.
- Exhaust fans are only used to remove air from inside to outside the room or in one direction.

Application

Exhaust fans cool down the indoor spaces, ventilate the hot and stuffy air, and can prevent the excess amount of moisture content effectively from building u in the damp areas.

3.4 SPDT Switch

A switch that has a single input and two dissimilar outputs is known as SPDT. The term SPDT stands for Single Pole Double Throw Switch which is used to control two dissimilar circuits through a similar single input. The operating of this switch can be done manually or included through the electromagnetic coil.



Figure 3.5: SPDT Switch

SPDT Switch Applications:

- This switch is used in a three-way circuit for controlling a load from two locations like from the top and bottom of a staircase.
- This switch is used to control two different circuits through a similar single input.
- Control Circuit.
- ABB/Siemens VFDs.

- PLC system output switches.
- Selector switches through a single common arrangement.

3.5 Easy EDA

Easy EDA is a web-based EDA tool suite that enables hardware engineers to design, simulate, share - publicly and privately - and discuss schematics, simulations and printed circuit boards. Other features include the creation of a bill of materials, Gerber files and pick and place files and documentary outputs in PDF, PNG and SVG formats. Easy EDA allows the creation and editing of schematic diagrams, SPICE simulation of mixed analogue and digital circuits and the creation and editing of printed circuit board layouts and, optionally, the manufacture of printed circuit boards.

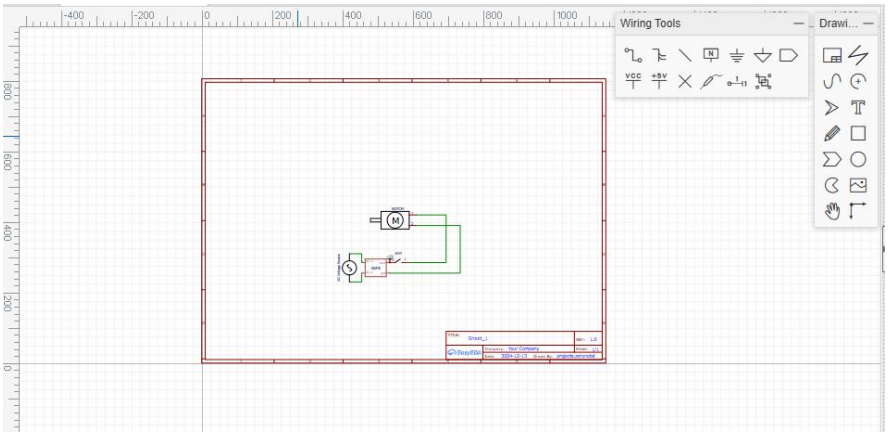


Figure 3.6: Easy EDA Software Interface

Subscription-free membership is offered for public plus a limited number of private projects. The number of private projects can be increased by contributing high quality public projects, schematic symbols, and PCB footprints and/or by paying a monthly subscription.Registered users can download Gerber files from the tool free of charge; but for a fee, Easy EDA offers a PCB fabrication service. This service is also able to accept Gerber file inputs from third party tools.

CHAPTER 4
METHODOLOGY

4.1 Our methodologies for the project

Our methodologies for the project:

- Creating an idea for design and construction of **Construction and Performance Test of Spot Welding Machine**. And designing a block diagram & circuit diagram to know which components we need to construct it.
- Setting up all the components in a PCB board & then soldering. Lastly, assembling all the blocks in a board and to run the system & for checking purposes.

4.2 Block Diagram

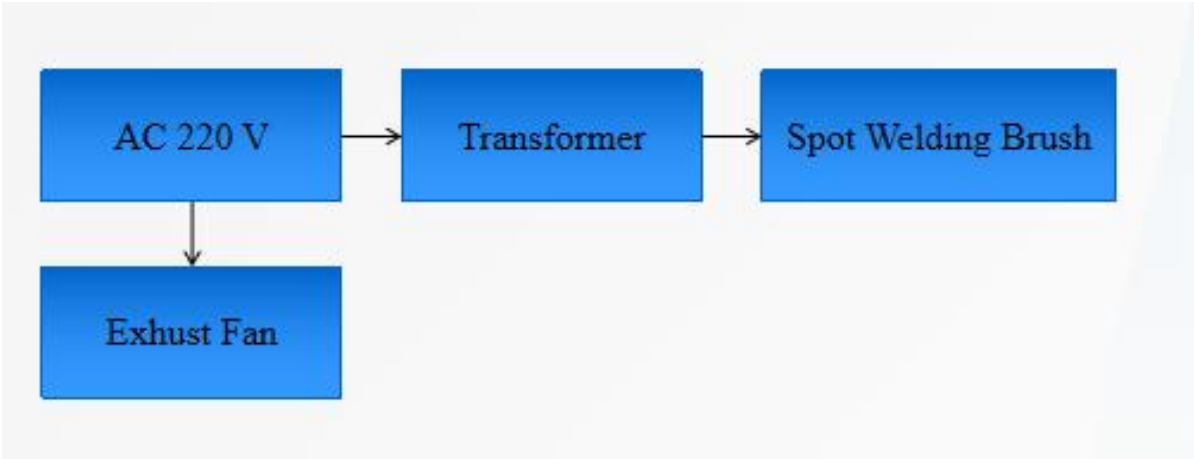


Figure 4.1: Block Diagram of Spot Welding Machine

4.3 Circuit Diagram of proposed Model:

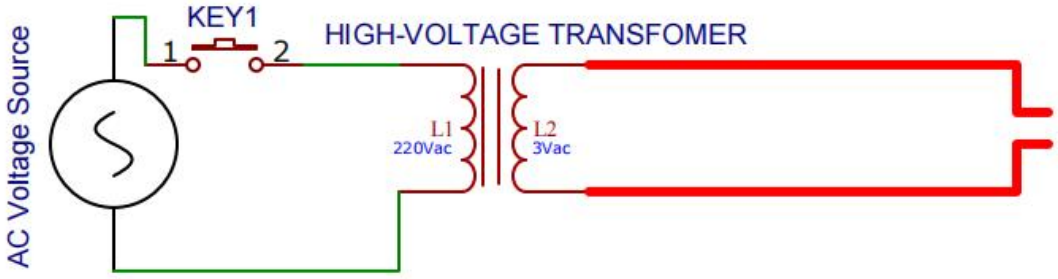


Figure 4.2: Circuit Design of Spot Welding Machine.

4.4 Working Principle

The working principle of a spot welding machine involves using electrical current to generate heat at the contact points of metal sheets, allowing them to fuse. The AC 220 V transformer steps down the voltage, supplying the necessary power to the machine. Once the metal sheets are positioned, electrodes apply pressure and conduct the electric current, melting the metal surfaces. After the welding process, an exhaust fan removes the generated fumes and smoke, ensuring a safe and clean working environment. This efficient setup allows quick and precise spot welding, making it ideal for various metal fabrication applications.

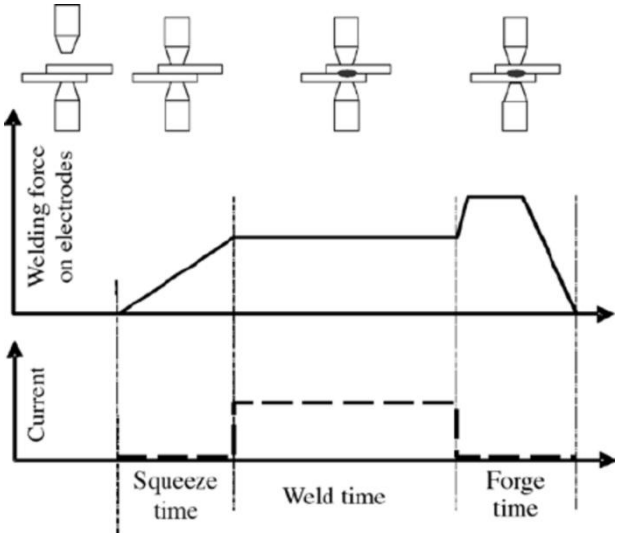


Figure 4.3: Working Process

4.5 Cost Analysis

Sl. No	Components Name	Quantity	Unit Price	Total Price
1	Transformer	1	5000	5000
2	Exhaust Fan	1	1500	1500
3	Feame		1200	1200
4	Others		1500	1500
Total				9200/=

4.6 Real View of project

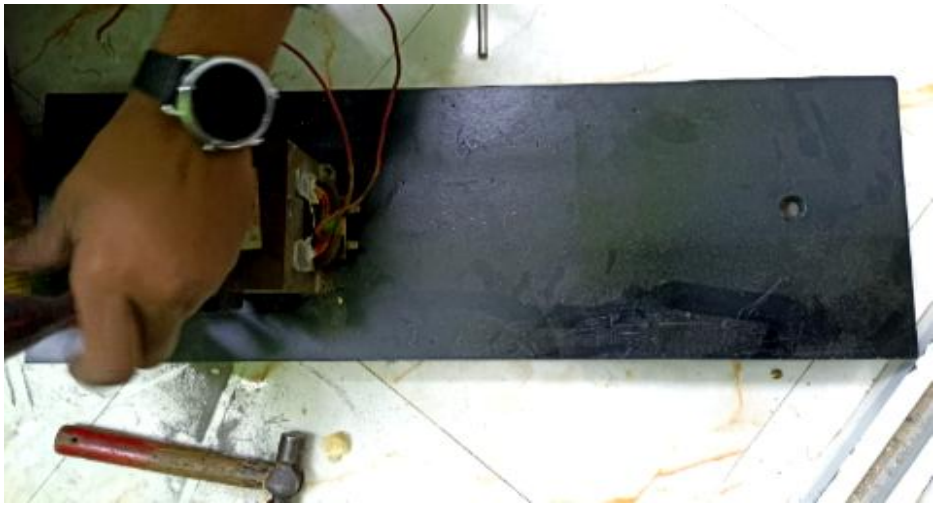


Figure 4.4: Our Project Hardware Image

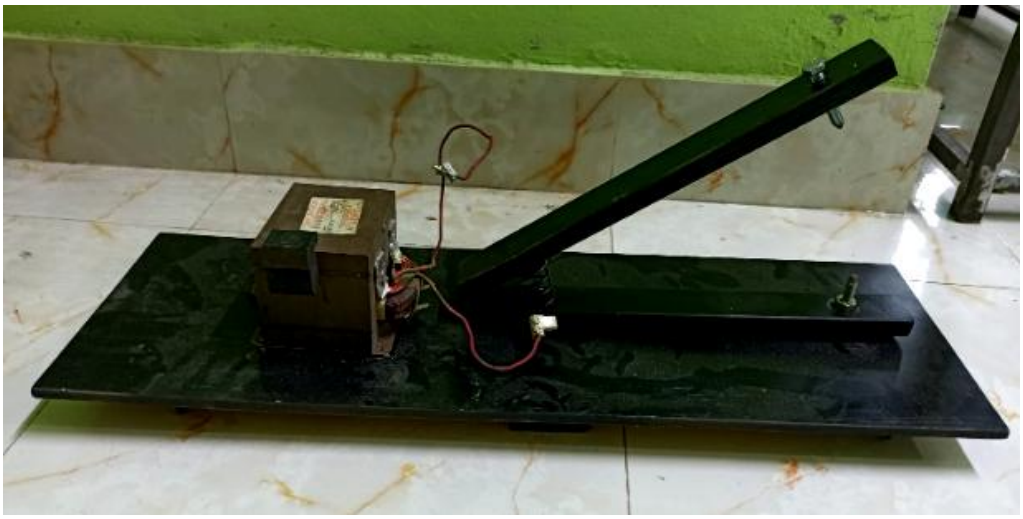


Figure 4.5: Our Project Progress Prototype

CHAPTER 5
RESULT AND DISCUSSION

5.1 Result

After making our project we observe it very careful. It works as we desire. Our project give output perfectly and all equipment are work perfectly. We check how much it works and we get perfect output from this project.

- Finally, we have completed our project successfully & check our project its run accurately according to our objective.
- At first, we connect the AC 220 to system on.
- Once the metal sheets are positioned, electrodes apply pressure and conduct the electric current, melting the metal surfaces.

Data Table: For Alloy Steel

No. Of Exp.	Metal Thickness (Alloy Steel)	Time (sec)
01	0.3 mm	10
02	0.5 mm	13
03	0.7 mm	15
04	0.8 mm	17
05	1 mm	21

Data Table: For Tin

No. Of Exp.	Metal Thickness (Tin)	Time (sec)
01	0.3 mm	07
02	0.5 mm	09
03	0.7 mm	13
04	0.8 mm	15
05	1 mm	17

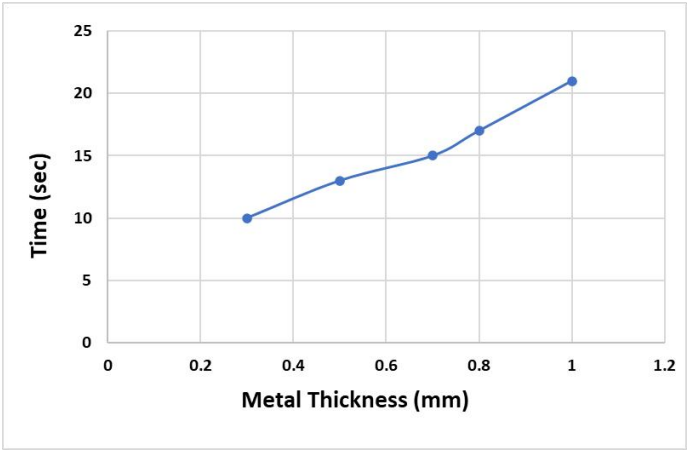


Fig 4.6 : Welding time for Alloy Steel depending on thickness

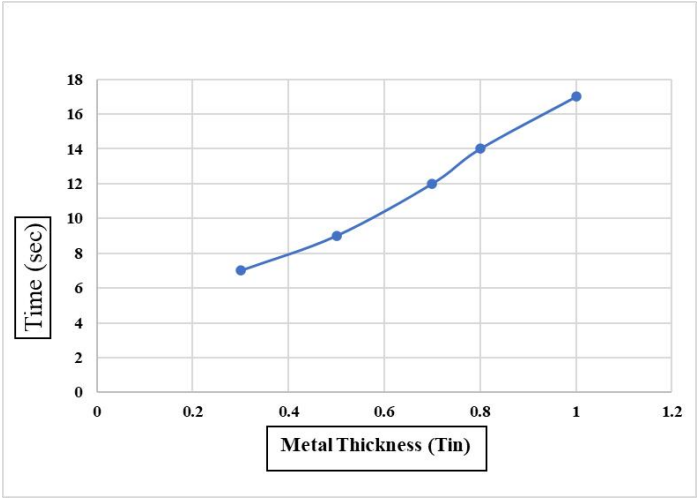


Fig 4.7 : Welding time for Tin depending on thickness

Performance Test for Tin

Test Type	Sample Data
Tensile Test	Maximum Load: 192 Newton, Extension at Break: 1.0 mm
Hardness Test	Hardness: 50 HV (Vickers Hardness)
Visual Inspection	Defects: Minor imperfections, Consistencies: None
Microscopic Inspection	Microstructure: Some grain boundaries visible

Efficiency Analysis:

Efficiency = (Actual Welding Thickness/Target Welding Thickness)×100%

For our machine:

Efficiency = (1.00 mm/1.50 mm)×100% = 66.67%

5.2 Discussion

While working on our project, we did face some difficulties as it is a very complex system but the end results, we came up with were quite satisfactory. We have put the whole system through several tasks to validate our work and also have taken necessary notes for future improvements. Some future recommendations that we have involves improvement in system design and wiring, adding features for more efficient.

5.3 Advantages

There are many advantages of our project because of its accuracy. Some of the advantages are pointed out below:

- Time saving machine for industrial work.
- Reduce energy waste.
- Less skill technicians is sufficient to operate.
- Less time and more profit.
- Ease of operation
- Safe and Clean
- Low Heat Affected Zone

5.4 Application

The application areas for this project in this modern and practical world are huge and some of these are given below:

- Industry
- Factory
- Electronics Assembly
- Metal Fabrication
- Heavy Machinery

5.5 Why do we use spot welding machines

We plan to use the spot welding machine for joining metal sheets efficiently in our production process. The machine will help create strong and durable joints by using electric current and pressure, ensuring precision and reliability. It works by generating heat at the contact points of the metal sheets through resistance, allowing them to fuse together. This method is ideal for our needs, as it is fast, cost-effective, and suitable for various thicknesses of metal sheets. With its key components like a transformer and

exhaust fan, the machine ensures smooth operation, making it a valuable addition to our workflow.

CHAPTER 6
CONCLUSION

6.1 Conclusion

The spot welding machine is an efficient and versatile tool for joining metal sheets through the application of heat and pressure. It offers significant advantages, including high production speed, low operational costs, and strong, durable welds. This welding technique is widely used in industries such as automotive, construction, and electronics, where precision and reliability are critical.Through this project, the design and functionality of the spot welding machine have been optimized to ensure efficient energy use and consistent weld quality. The machine's ability to produce clean and uniform joints without the need for additional materials highlights its cost-effectiveness.

In conclusion, the spot welding machine is a vital technology for modern manufacturing, offering a practical and economical solution for metal joining. Its application supports mass production, enhances product quality, and contributes to the advancement of automated and sustainable industrial practices.

6.2 Future Work

We are thinking about adding many features to our project in the future to get more desirable out comes. Some of the steps that we are thinking about taking are given below:

- In future develop Automation Integration
- In future we will add IoT System to operate in fully automatically.
- In Future Develop Robotics and Machine Learning

REFERENCE

[1] Pouranvari M, Marashi SPH. Critical review of automotive steels spot welding: process, structure and properties. SciTechnol Weld Join 2013; 18:361-403.

[2] Alizadeh-Sh, M., Marashi, S. P. H., & Pouranvari, M. (2014). Resistance spot welding of AISI 430 ferritic stainless steel: phase transformations and mechanical properties. Materials & Design, 56, 258-263.

[3] S. Aslanlar, A. Ogur, U. Ozsarac, E. Ilhan. "Welding time effect on mechanical properties of automotive sheets in electrical resistance spot welding". Volume 29 (7), 2008, Pages 1427-1431

[4] Hernandez, V. H. B., Panda, S. K., Okita, Y., & Zhou, N. Y. (2010). A study on heat affected zone softening in resistance spot welded dual phase steel by nano indentation. Journal of materials science, 45(6), 1638-1647.

[5] Lee, Y. L., Wehner, T. J., Lu, M. W., Morrissett, T. W., & Pakalnins, E. (1998). Ultimate strength of resistance spot welds subjected to combined tension and shear. Journal of Testing and Evaluation, 26(3), 213-219.

[6] Marashi, P., Pouranvari, M., Amirabdollahian, S., Abedi, A., &Goodarzi, M. (2008). Microstructure and failure behavior of dissimilar resistance spot welds between low carbon galvanized and austenitic stainless steels. Materials science and engineering: A, 480(1), 175-180.

[7] Aslanlar, S., Ogur, A., Ozsarac, U., Ilhan, E., &Demir, Z. (2007). Effect of welding current on mechanical properties of galvanized chromided steel sheets in electrical resistance spot welding. Materials & design, 28(1), 2-7.

[8] Kahraman, N. (2007). The influence of welding parameters on the joint strength of resistance spot-welded titanium sheets.Materials& design, 28(2), 420-427.

[9] P. Sathiya ,K.Panneerselvam, R.Soundararajan, ―Optimal design for laser beam butt welding process parameter using artificial neural networks and genetic algorithm for super austenitic stainless steel.‖, Optics & Laser Technology 44 (2012) 1905–1914, 18 January 2012.

[10] G.R. Mirshekari, A. Saatchi, A.Kermanpur , S.K.Sadrnezhaad , ―Laser welding of NiTi shape memory alloy: Comparison of the similar and dissimilar joints to AISI 304 stainless steel‖, Optics & Laser Technology 54(2013) 151–158, 17 May 2013.

[11] Lifang Mei , Genyu Chen, Xiang zhong Jin,Yi Zhang, Qiang Wu , ―Research on laser welding of high- strength galvanized automobile steel sheets‖, Optics and Lasers in Engineering 47 (2009) 1117–1124, 30 June 2009.

[12] A.G. Olabi, F.O. Alsinani, A.A. Alabdulkarim, A. Ruggiero, L. Tricarico , K.Y. Benyounis, ―Optimizing the CO2 laser welding process for dissimilar materials, Optics and Lasers in Engineering 51 (2013) 832–839, 20 January 2013.

[13] Shanmugarajan B., Chary J N. , Padmanabham G. , Arivazhagan B. , Shaju K. Albert , Bhaduri A.K., ―Studies on autogenous laser welding of type 304B4 borated stainless steel‖, Optics and Lasers in Engineering51(2013) 1272–1277, 4 May 2013.

[14] Mingjun Zhang, Genyu Chen , Yu Zhou, Shenghui Liao, ―Optimization of deep penetration laser welding of thick stainless steel with a 10 kW fiber laser‖, Materials and Design 53 (2014) 568–576, 27 Jun 2013.

[15] Squillace, U. Prisco, S. Ciliberto, A. Astarita, ―Effect of welding parameters on morphology and mechanical properties of Ti–6Al–4V laser beam welded butt joints‖, Journal of Materials Processing Technology 212 (2012) 427– 436, 10 October 2011.