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Portable tack welding device

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Abstract: The main purpose of this study was to develop a portable electronic tack welding device and determine its tacking time duration, power consumption and tacking operation. This was based from the principles of resistance spot welding with the purpose of joining sheet metals by fusing through resistance heating on tacking operation. This study employed developmental method of research wherein an innovation was made in a spot welding. The data were gathered using actual experimentation and evaluation sheet. The device was evaluated by Forty (40) evaluators including twenty (20) professors in the academe and twenty (20) experts in the field of electrical, automotive and metal craft industry. This study was limited to the development of the portable electronic tack welding device intended for fusing steel sheets ranging from gauge # 21 to gauge # 25. The parameters measured were the tacking duration, the power consumption and the fused result of the tacking operation on varied steel sheet thickness and will undergo in three (3) trials of testing. The level of acceptability was evaluated in terms of its design, composition and operating performance. The study showed that the tacking duration of the device showed that as the gauge thickness increased the slower is the tacking time however there was an increased in the power consumption. Likewise, the device was able to fuse together the given thickness of steel sheets after the tacking operation. The device was also evaluated its overall acceptability in terms of design, composition and operating performance as “very acceptable”.

Keywords: Tack welding, Portable, Steel sheets, Electronic switching circuit

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INTRODUCTION

Technological advancement leads to the improvement of every day’s life. There are vast productions of different types of inventions that were designed for convenience. A lot of development and innovations are created due to the fast demand of the market to produce a unique and useful device with specific function to the users in household, establishments and in industries (Barrion, et al, 2017).

Resistance spot welding is among the oldest of the electric welding method that used in the industry and it is useful and accepted method in joining metal. Spot welding is widely used in welding carbon steel because they have higher electrical resistance and lower thermal conductivity than the electrode made of copper. The spot welding is commonly being used in automobile industry, where it is used to weld the sheet metal forming a car. Spot welders can also be completely automated, and many of the industrial robots found on assembly lines are spot welders. Spot welding also being used in the repair industries (Raut, et al., 2014).

But the spot welding machine requires a lot of space for operation. It is also heavy, bulky and as well as costly. In order to overcome this problem, it should be recreating its design with the same principles of operation. Making it portable, simple and light to be carried anytime from any place for tacking purposes and can be easily operated by even a non-skilled labor with much ease and required accuracy (Sreenivasulu, et al., 2018).

In line with this, the researcher was challenged to develop the device for the end users of the product and make some innovation for other additional purposes. This will lessen the burden in fusing steel sheets without many required processes.

It is in this premise that the researcher pursued to conduct this study entitled "Portable electronic tack welding device". The target of this research was to develop a tack welding device which simplifies the work of the users. The working principle of this device is the same as that of other spot welding machine but with special features.

Statement of the problem

The main purpose of this study was to develop a portable electronic tack welding device.

Specifically, it aimed to:

1) determine the tacking duration of the portable electronic tack welding device in fusing varied thickness of steel sheet;

2) determine the power consumption of the portable electronic tack welding device with load;

3) find out the fused result of the portable electronic tack welding device when tacked on varied steel sheet thickness; and

4) find out the level of acceptability of the portable electronic tack welding device in terms of feature, composition and operating performance.

METHODOLOGY

Research design

This study employed a developmental research design aimed at creating or improving a product to assess its effectiveness and usefulness. Specifically, the study focused on the design and development of a portable electronic tack welding device based on resistance spot welding principles. The innovative design incorporated features like electronic switching and a control circuit, providing enhanced functionality and safety.

Locale of the study and respondents

The study was conducted in a setting conducive to the development and evaluation of the portable tack welding device. The respondents comprised evaluators from both academia and industry. A total of forty evaluators—twenty from academic institutions and twenty from industry—assessed the device's features, composition, and operational performance. These evaluators provided critical feedback and recommendations for improvement.

Research instruments

The instruments used included actual observation sheets and evaluation sheets developed by the researcher. The observation sheets captured data on the device's tacking duration, power consumption, and fused results for steel sheets of varying thicknesses. The evaluation sheets, validated by experts, rated the device's acceptability based on features, composition, and operating performance using a five-point Likert scale. Additionally, instruments like a stopwatch and caliper measured tacking duration and steel sheet thickness, while analog and digital multitesters assessed power consumption.

Data analyses procedure

Data analysis involved computing the mean to determine the tacking duration, using binary and Likert scales to interpret the fused results and acceptability levels. The tacking duration was classified into categories (e.g., very fast, moderately slow) based on mean scores. The binary scale evaluated whether steel sheets were successfully fused. The power consumption of the device was calculated using voltage and current measurements, while the acceptability of the device was interpreted using weighted means from the Likert scale. Finally, evaluators' feedback was consolidated for recommendations to enhance the device.

FINDINGS AND DISCUSSION

Tacking duration of the portable electronic tack welding device in fusing varied thickness of steel sheet

The discussion of the tacking duration result of the portable electronic tack welding device in fusing gauge # 21 steel sheet thicknesses. Data revealed that the device was able to obtain a total mean time in seconds of 4.69 out of 3 trials and verbally interpreted as “fast”. In gauge # 23, it got a total mean time of 2.22 out of 3 trials, verbally interpreted as “moderately fast” and in gauge # 25, got a total mean time of 1.89 out of 3 trials and also verbally interpreted as “very fast”. This implies that the device got slower time tacking duration on fusing the steel sheets as the thickness of the metal increases, the electrode force when tack and the diameter of the workpiece were being used. The device can make faster tacking penetration on thinner size of workpiece and even it can totally melt or make holes out of that tacking operation rather than weld (Entron Controls LLC, 2014)

In conform on the work of Sreenivasulu, et al., (2018) on Fabrication and Analysis Of Portable Spot Welding Machine, they consider the type and the thickness of sheet metal used in their experiment in order to gather information about the time duration of weld with their machine and the result were using 1mm thickness plates takes 1.7 sec to fuse and the thicker plates which was the 5mm takes 7.4 sec. According to them, the averagely time for welding with their machine was 5 sec and the maximum thickness of plate is 5mm.

Tacking duration of the portable electronic tack welding device in fusing varied thickness of steel sheet.

Power consumption of the portable electronic tack welding device with load

The discussion of the power consumption result of the portable electronic tack welding device with load. In gauge # 21, the tacking operation with the overall total average wattage of 1,184.39W in three trials of testing got a result in 1.184 Kw/Hr of power consumption multiplied to the electric company power cost of Php 6.79 per hour got Php 8.04. the same calculation used in gauge # 23 which got overall total average wattage of 1,072.70W and result of 1.072 Kw/Hr of power consumption multiplied to the electric company power cost of Php 6.79 per hour got Php 7.28 and in gauge # 25 of steel sheet with overall total average wattage of 973.41 in 0.973 Kw/Hr of power consumption multiplied by Php 6.79 per hour got Php 6.61.

This means that the power consumption of the portable electronic tack welding device ranges from nine hundred seventy (970) watts up to one thousand two hundred(1200) watts in every hour of operation and it could be the power cost per hour of operation would turned to Php 6.60 to Php. 8.00. As the device designed for portability, its power consumption was made lesser than those resistance spot welding machines exist but it compromises its performance and length of tacking operation for small scale used only (Entron Controls LLC, 2014).

Fused result of the portable electronic tack welding device when tacked on varied steel sheet

Thickness

The fused result discussion of the portable electronic tack welding device as tacked on varied steel sheets thickness. Data showed that in gauge # 21, the device was able to obtain a total mean of 1 out of 3 trials which means that the device was able to fuse the steel sheets together with the tacking operation with the verbal interpretation of “Fused”. The same results with gauge # 23 and gauge # 25 in three trials also, which give implications that the device was able to fuse together the given thickness of steel sheets with the tacking operation with the overall verbal interpretation of “Fused”. As the required proper materials, processes and techniques provided, the user of the device will be able to fuse the metal sheets and make a good welds on the workpiece. Avoiding other factors should be done so that may not affect the output rather to produce reliable welds. Applying too little energy will not melt the metal or will make a poor weld. Applying too much energy, too much pressure and longer tacking operation will melt too much metal, eject molten material, and make a hole rather than a weld (Entron Controls LLC, 2014)

In conform with the Experimental Study of Spot Weld Parameters in Resistance Spot Welding Process (Habib, et al., 2017), the tensile tests (fuse force) and the spot welding diameters were carried out to show the influence of thickness sheet, type material, and electrical current and welding time in resistance spot welding process. From the results obtained, those parameters have an influence in resistance spot welding process to produce good and reliable weld.

Overall acceptability of portable electronic tack welding device in terms of design, composition and operating performance

Based on the evaluation result for the acceptability of portable electronic tack welding device in terms of the design, the data showed that the average mean result for the design was 4.82 and verbally interpreted as very acceptable. This implies that the design provides safety features and portability to the users which the device made simpler and lighter so it can be carried and transferred to another place. The evaluators agreed that the device was designed for tacking or fusing steel sheets with required thickness of workpiece in every operation and did not limit its uses for another purposes.

In conforms of the study of Atinon (2017) the design of the Solar Nichrome Wire Polystyrene Cutter (SNWPC) was rated “Very Acceptable” due to its creativity, simplicity and can be easily manipulated or operated.

For the acceptability of portable electronic tack welding device in terms of the composition got an average mean result of 4.86 and verbally interpreted as very acceptable. This implies that the device is safe for the user to operate because it has electrical controls and protection although the tacking operation produces sparks and extreme heat when it is used continuously but it is already considerable.

In conforms of the study of Somil (2015) the Automatic photo sensor controller was very acceptable as to its composition in terms of “Professionally done” , “quality of material used”, “standard instruction”, “protection from environmental hazards”, and “industrial planning”.

Likewise, the operating performance of the device was very acceptable in terms of “Capacity to operate within a 12 hour period”, “capacity up to 100 watts”, “scientific procedure”, “easy installation and replacement of parts and “safety protection”. Furthermore, the general acceptability of the device was very acceptable in term of design, composite on and operating performance.

On the other hand, the acceptability of portable electronic tack welding device in terms of the operating performance got an average mean result of 4.9 and verbally interpreted as very acceptable. This implies that the device must have powerful welding transformer for better operation and it should be used with proper instruction and expertise even if it easy to operate with minimal limitation in time of operation and it has also a required thickness of steel sheets to be used as workpiece.

In contrast to the study of Bin Din (2008) in comparison of effect of welding time on coach peel strength and tensile shear strength, the weld current period and weld time is 3 – 6 kA and 2 – 5 second respectively was selected during the welding process. The experiment increasing welding time caused high heat input to weld zone and extending weld nugget, so the strength of joints increases mine while excessive heat energy input causes void and crack formations, partially spurt out of molten metal and so, the strength of joint decreases. The optimum parameter for tensile shear type is at 6 ampere (A) current and 4 second welds time (3847 N) and the highest strength for coach peel type is at 6 ampere current and 5 second welds time (889.5N). Finally the comparison result shown the higher strength of orientation using spot welding machine is tensile shear type.

The device was evaluated its overall acceptability in terms of design, composition and operating performance with the overall mean result of 4.86 and was interpreted as very acceptable.

CONCLUSIONS AND RECOMMENDATIONS

As the thickness of the steel sheets increases, the device got slower time tacking duration in fusing the steel sheets. While the power consumption of the device ranges from nine hundred seventy (970) watts up to one thousand two hundred(1200) watts in every hour of operation and the power cost per hour of operation would be Php 6.60 to Php. 8.00. Likewise, the device was able to fuse together the given thickness of steel sheets through tacking operation. The device was evaluated in terms of design, composition and operating performance and very acceptable. Thus, the developed device is preferred by the evaluators because of its lower power consumption.

It is highly recommended for fusing or joining steel sheets ranges from gauge # 21 to gauge # 25. Also recommended for fusing other small pieces of metals like nails, screw, washer, nuts and other weldable materials. Use larger type of transformer to produce larger amount of current for increasing thickness of steel sheet to be fuse. Likewise, use the device with the appropriate material to be tack or fused only based on its specification and capacity. Recommended for intermittent used only and for small scale operation, it could not be used for long period of time and should be place on flat area and away from any flammable materials. Further study is encouraged to improve the functions and additional features of the device.

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