



SUPER CAPACITOR BASED AUTOMATED SPOT WELDER

Engineering

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ABSTRACT

Quality assurance has been of a great concern in the process of resistance spot welding, since considerable variation in the weld quality often arises even when the machine variables are held constant. Resistance spot welding is used frequently as a successful joining method for a variety of work commonly in automotive and other manufacturing processes. Spot weld nugget is generally hidden between two sheets, causing its inspection difficult and expensive. Undersized nuggets and excessive-indentation of electrodes reveals the lack of fusion between the parts that can make the weld sub-standard. Visual inspection, pry testing and physical teardown with chisel and hammer method or a combination of them are being used traditionally. This is occur in three stages: Electrodes seated in a weld head are brought to the surface of the parts to be joined and force is applied. Thicker stock is more difficult to spot weld because the heat flows into the surrounding metal more easily. It can be easily identified on many sheet metal goods, such as metal buckets. A large current through the spot will melt the metal and form the weld. The advantages of super capacitor based automated spot welding is widely used in the automotive industries and the process is simple and fully automated so does not required high skills labour and high production rate.

KEYWORDS

Super capacitors, active components (MOSFET, IR2110 DRIVER).

I. INTRODUCTION

Quality assurance has been of a great concern in the process of spot welding. In Electric Resistance Welding (ERW) methods, a high current is passed through the metal pieces to be joined together and the heat is produced due to the resistance in the electric circuit. This heat energy is utilized to increase the temperature of a localised spot of the work pieces to produce coalescence, and then applying pressure at this spot till welding takes place. Electric resistance welding process is a pressure welding process and not a fusion welding process. The output of heat, in this process can be easily calculated. Heat generated is proportional to I^2Rt . Supercapacitors are advanced electric energy devices with much higher capacitance in relative small packages. Both of them consist of two electrodes (plates) separated by a dielectric but supercapacitors utilize thinner dielectric and higher surface area electrodes which allow higher energy density. Supercapacitors are used in a wide range of applications from low to high power applications. Spot welding consists of joining two pieces by placing them between two electrodes and passing a heavy current through them for a very short duration. This causes the material just below the electrodes to heat up quickly due to the intervening resistance to the flow of electric current. When coalescence temperature is reached, the current is switched off and a pressure is applied on the two electrodes.

II. LITERATURE SURVEY

The paper gives the information about super capacitor. In 1960s, the Standard Oil Company, Cleveland, Ohio (SOHIO) invented a first cell comprising two layers are made from activated charcoal separated by a thin porous insulator. This technology became the basic concept for the present double-layer capacitors [1].

The paper presents the results of experimental research on resistance spot welding with stored energy in the capacitor of metallic amorphous ribbons with a thickness of $50\mu\text{m}$ (0.05 mm) in order to establish of welding technologies. Resistance spot welding with stored energy in capacitors is applied to thin sheet or foil due to very precise energy input in the components at the capacitors discharge. The resistance spot welding with stored energy in capacitors is based on a capacitor discharge phenomenon over the primary winding of welding transformer which makes to occur a welding current in the secondary winding of the transformer [2].

The paper include information of JFE Steel which introduces a new welding process (12-14) which was developed by focusing on variable control of the welding current and electrode force during welding in indirect type single-side resistance spot welding. Although this type of variable control had not been studied in the past, with the newly-developed process enables to obtain stable nugget formation in spite of changes in the shunting condition and to suppress expulsion. First, the welding conditions for promoting nugget formation and suppressing expulsion were predicted by numerical simulation [3].

The work, an open architecture capacitive discharge welding system has been conceptualized, designed, assembled, and demonstrated. The system design is based on supplying a polarity switched CD-based current pulse to a stacked-core transformer arrangement. This resulted in a system with wide flexibility in matching power supply outputs to secondary loading [4].

The idea behind Capacitor discharge welding is the relatively slow storage of energy that is then released very quickly, permitting extremely high currents in milliseconds and Capacitor discharge welding is showing advantages for welding hot-stamped boron steels for use in the automotive industry. Capacitor discharge welding has been widely used in many countries for many years, especially where electricity is expensive or the electrical grid itself is unreliable [5].

This planar transformer offers a higher efficiency, lower stray inductance, lower weight and a higher control frequency compared to available transformers. Due to decreased losses forced air cooling is sufficient for a dc output current up to 2.7kA. The operating mode of the transformer and the synchronous rectifier were described and a modulation scheme was derived [6].

The topology integrates a buck-type Power Factor Correction (PFC) cell with a buck-boost dc/dc cell and part of the input power is coupled to the output directly after the first power processing. With this direct power transfer feature and sharing capacitor voltages, the converter is able to achieve efficient power conversion, high power factor, low voltage stress on intermediate bus (less than 130 V) and low output voltage without a high step-down transformer [7].

III. PROPOSED SYSTEM

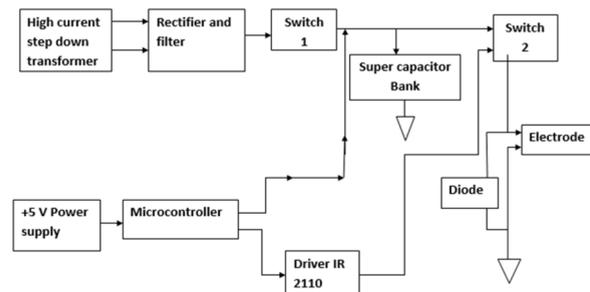


Fig.1 Super Capacitor Based Automated Spot Welder

The proposed system provide below features:

The above diagram shows working of proposed system. The input power for this system comes from a wall outlet, and is converted from 120 VAC to a more appropriate voltage (on the order of 16 VAC). This AC waveform is converted to a smooth DC wave form by a bridge rectifier and a parallel capacitor, creating an approximately constant voltage for the buck convert and the associated control circuits for the later stages of the welder. The buck converter acts as a current limiting charging circuit for the capacitor. Input from a current sense resistor in series between the buck output and the capacitor is used to determine the current being used to charge the capacitor

The buck converter will regulate the duty cycle to remain at the appropriate voltage for that energy storage level. If the capacitor voltage is less than the desired voltage, the output pulse control will be disabled. The capacitor is connected to a high current MOSFET, and this switch is connected to the output electrodes of the device. A foot switch will be used to trigger the pulse - the length of this pulse is variable and also controllable by the user transistors. The output connection consists of two segments of 8 gauge automotive copper wire, connected at the end to two copper electrodes ground to a point. Each electrode is mounted in an insulating metal rod, and the top of these metal rods are the only accessible parts of the project. The work pieces and electrodes will be enclosed inside a wood and polycarbonate box to prevent any harm from arcs or metal splatter. The capacitor will also be enclosed within a separate box, in case of a catastrophic failure. As a safety feature, there is also an additional capacitor discharge channel composed of a MOSFET and a power resistor. This channel has a toggle switch and allows a user to safely discharge any excess energy in the capacitor without having to use the welder.

E.g. assume a lead acid battery which has energy density 250W/kg. It replace by super capacitor.

Assume C = 350F 2.5v

By formula of Energy Density

$$U = \frac{1}{2} C V^2 \dots\dots\dots [1]$$

$$U = 0.5 * 350 * 2.7^2$$

$$U = 1275.75 \text{ W (only one capacitor is used)}$$

When capacitor in series

$$\frac{1}{C} = \frac{1}{C1} + \frac{1}{C2}$$

$$\frac{1}{C} = \frac{C1+C2}{C1*C2}$$

Let's 5 capacitor connected in series C=[350]

$$\frac{1}{C} = \frac{1}{350} + \frac{1}{350} + \frac{1}{350} + \frac{1}{350} + \frac{1}{350}$$

$$\frac{1}{C} = \frac{1}{70}$$

Put value in equation [1]

$$U = \frac{1}{2} C V^2$$

$$U = 0.5 * 70 * 2.7^2$$

$$U = 255 \text{ W}$$

Where, U= Energy density, V= Applied voltage, C= Capacitance in Farad.

IV. RESULT

This construction is used to store energy into a huge super capacitor bank, and discharge it via electrode in the given target, regularly metals such as copper rod. The logic timing (of the order of 20-30msec) is controlled by ATMEGA 328p. High current pulse is delivering to the electrodes when the trigger button is pressed. Metal wire or copper rod pressed between the electrodes will be melt and weld together.

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VI. CONCLUSION

The main focus is to propose an automated system which can weld the two plates. This automotive process can improve the accuracy and reduce the time to weld by using super capacitor approach. This process is simple and fully automated so, does not required high skills and high production rate.

VII. REFERENCES

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