DEVELOPMENT OF MULTI-POINT RESISTANCE WELDING ELECTRODE

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ABSTRACT

Welding is metallurgical fusion process. Here, the interface of two part to be joint are brought to a temperature above the melting point and then allowed to solidify so that a permanent joining take place. Because of permanent nature of joint and its strength being equal to or sometimes greater than that of parent material, Resistance welding is fusion welding process in which a low voltage and very high current is pass through joint for a very short time. This high amperage heats the joint due to the contact resistance at the joint and melts it. The pressure on the joint is continuously maintained and the metal fuses together under this pressure. In this paper we are going to discus on multi point electrode (plate) to increase the productivity in minimum time, by reducing human fatigue , and man and machine hour.

Keyword : - . *interface ,Resistance welding,productivity, fatigue.*

1. INTRODUCTION

Welding is metallurgical fusion process. Here, the interface of two part to be joint are brought to a temperature above the melting point and then allowed to solidify so that a permanent joining take place. Because of permanent nature of joint and its strength being equal to or sometimes greater than that of parent material, welding is one of the most extensively used fabrication method. It is not only used for making structure but also for repair work such as the joining of broken castings. The product obtain by the process of welding are called weldments.

Based on the type of joint and source of heat input the welding processes are classified as follows:

[A] Arc welding(AW)

[B] Solid state welding

[C] Resistance welding

[D] Soldering

[E] Brazing

1.1 Principle:

Resistance welding is fusion welding process in which a low voltage and very high current is pass through joint for a very short time. This high amperage heats the joint due to the contact resistance at the joint and melts it. The pressure on the joint is continuously maintained and the metal fuses together under this pressure. The schematic representation of the resistance welding process is shown in figure.

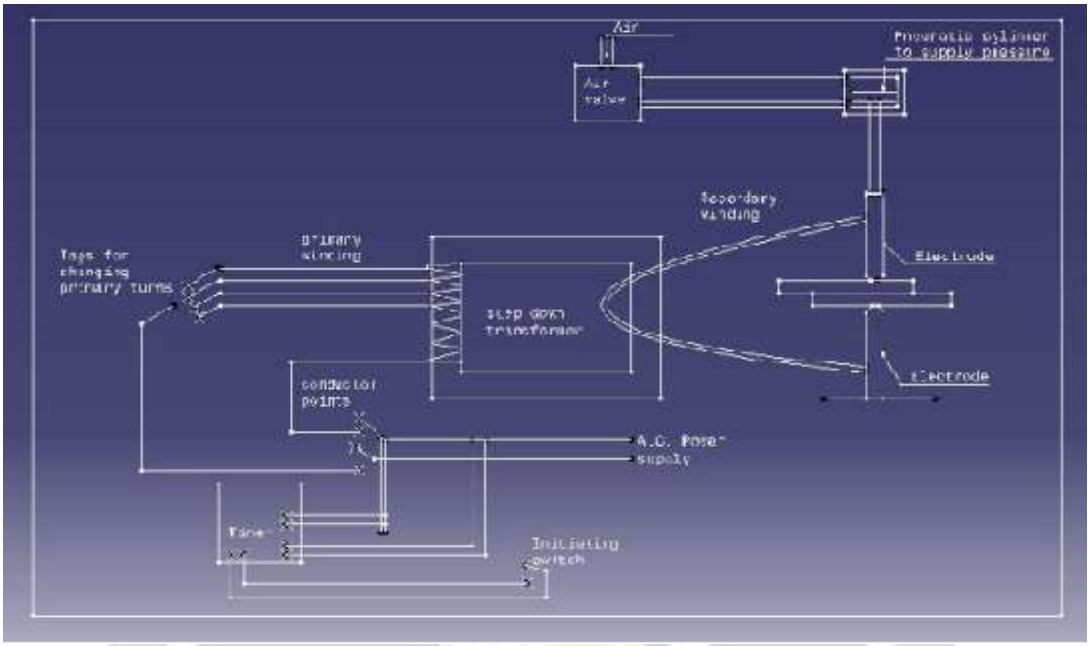

Fig. 1 principle of resistance spot welding

The main requirement of the process is the low voltage and high current power supply. This is obtained by means of step down transformer with a provision to have different tapings on the primary side. The secondary winding's are connected to the electrodes, which are made of copper to reduce their electrical resistance. The time of electric supply needs to be closely controlled so that the heat released is just enough to melt the joint and the subsequent fusion takes place due to the force(forge welding on the joint). Force required can be provided either mechanically, hydraulically or pneumatically.

2. QUALITY ISSUES

In order to perform efficient welding following defects, while performing welding should be minimized.

2.1 Cracks:

Cracks may be on microscopic scale or macroscopic scale depending up on there size. Cracks may be on the weld surface or under the weld bead. The causes of crack formation are:

- Poor ductility of base metal
- Rigidity of joint
- Harden ability
- Concave weld bead
- Fast arc travel speed

2.2 Incomplete Penetration:

Penetration is the distance from base plate top surface to the maximum extent of the weld nugget. The causes of incomplete penetration are:

- Improper joint
- Too large root face

- Root gap too small
- Less arc current
- Faster arc travel speed

2.3 Poor fusion

Sometimes the molten metal deposited by the electrodes does not fuse properly with the cold base metals and the two do not unite properly and completely. It may be lacking at the root, or between two runs in a multi run belt. The causes of incomplete poor fusion are:

- Incorrect joint preparation
- Incorrect electrode manipulation
- Due to presence of oxides, rust, scale it do not permit welding properly

2.4 Distortion

It is the change in shape and difference between the positions of the two plates before welding and after welding. The causes of distortion are;

- More number of passes with small diameter electrodes.
- Slow arc travel speed.
- Type of joint.
- High residual stresses in plate to be welded.
- Welding process being improved.
- Used of jigs and fixture, claps, presetting, welding and proper tacking may minimize distortion.

2.5 Inclusion

It may be in the form of slag or any other foreign material,which does not get a chance to float on the surface of solidifying weld metal and thus gets entrapped inside the same.

The various causes of inclusion;

- Too large electrode diameter.
- Too small included angle of the joint.
- Current variation.

3. WELDING PARAMETER:

3.1 Squeeze time:

It is the time between the initial application of the electrode pressure on the work and the initial application of current to make the weld. During this period the upper electrode comes in contact with the work piece and developed full electrode force. At the end of the squeeze time, the welding current is applied.

3.2 Weld time:

During this period the welding current flows through the circuit, i.e., it enters from one electrode, passes through the work piece and goes out from the second electrode.

3.3 Hold Time:

It is the time during which force acts at the point of welding after the last impulse of welding current ceases. The electrode pressure is maintained until the metal has somewhat cooled.

3.4 Off Time:

It is the interval from the end of the hold time to the beginning of the squeeze time for the next (Resistance) welding cycle. The time during which the electrodes are off the work. ("Off Time" is an optional timing function used for automatic-repeat operation and is not necessary to produce a weld.)Other timing sequences and control functions may be required for specific applications.

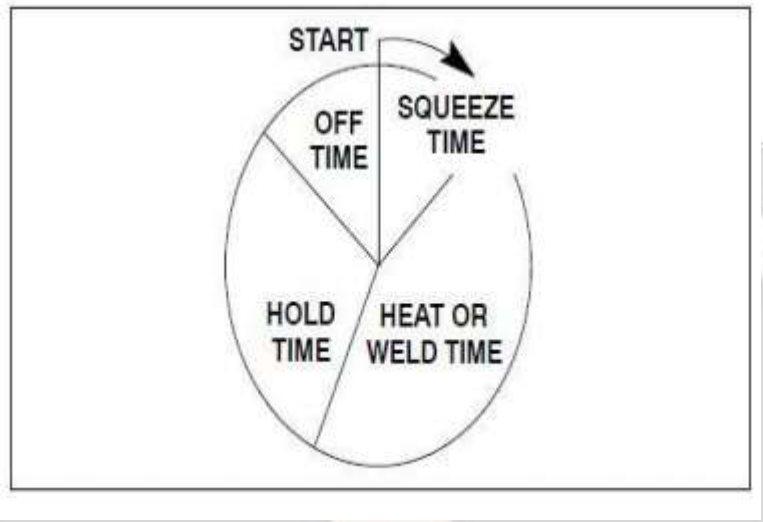

Fig. 2 Welding Cycle

4. LITERATURE REVIEW

Larry Montanez III et.al. the procedures for making proper resistance welds every time, which in turn will ensure proper, safe repairs. Due to the advanced material usage in today's vehicles, many OEMs are developing their own certified collision repair programs – not just for their aluminum-intensive vehicles, but for their steel- intensive vehicles, too. OEMs with certified programs and equipment requirements are Audi, BMW, Chevrolet Corvette Z06/ZR1, Chrysler/Jeep, Ferrari, Jaguar, Lamborghini, Mercedes Benz, McLaren, Nissan GT-R, Porsche, Toyota and Volkswagen. Additionally, almost every OEM, at the least, makes a suggestion in their collision repair information as to what welding equipment to use.

M,Rashid et.al.Oxide layer cracking and nugget formation were focused. Both experimental work and finite element analysis were employed to explain the contact behavior at this interface. It was found that sheet separation and thus bending occurred during the squeezing phase of the resistance spot welding process and suggested a profound influence on nugget formation. The sheet separation caused enlarged and aligned cracks in the surface oxide layers which led to a good metal-to-metal contact near the periphery of the surface. High current densities which occurred at the beginning of the current phase caused significant heat generation in this zone. Consequently, the melting at the surface started near the periphery and moved in towards the central zone of the contact region to produce a 'dough-nut shaped' nugget with a filled-in but thin central region.

Mustafa Kemal et.al. The process is performed by plunging a rotating pin that creates a connection between sheets in an overlap configuration by means of frictional heat and mechanical work.The tensile-shear-strength and hardness

variations in the weld regions are discussed. The results obtained are compared with those derived from the application of traditional resistance spot welding (RSW). The experimental results of the study show that FSSW can be an efficient alternate process to electrical resistance spot welding.

Norasiah Muhammad et.al.The effects of four factors namely weld current, weld time, electrode force and hold time were studied using a general 24 factorial design augmented by five Centre points. The results of the analysis showed that all selected factors except hold time exhibit significant effect on weld nugget radius and HAZ size. Optimization of the welding parameters (weld current, weld time and electrode force) to normalize weld nugget and to minimize HAZ size was then conducted using Central Composite Design(CCD) in Response Surface Methodology (RSM) and the optimum parameters were determined. A regression model for radius of weld nugget and HAZ size was developed and its adequacy was evaluated. The experimental results obtained under optimum operating conditions were then compared with the predicted values and were found to agree satisfactorily with each other.

5. PROBLEM BACKGROUND

In this Project while performing spot resistance welding following problems are arises which are also describe in briefly in above ergonomics consideration section.

- Fatigue to operator by means of continuous pedaling.
- Process cycle time is more.
- Single spot at a time.
- Heating of transformer due to controller action.
- Wear of electrodes.
- Manpower requirement is more.
- Manual force requirement is more.

5.1 Objectives:

The main objectives of project to be achieved are:

1. Process cycle time required is less.

2. Multi spot at a time.

3. To increase the productivity.

4. To reduce operator fatigue.

6. MODIFICATIONS/ SOLUTIONS

6.1 Development Of Arm:

Development of arms means, the square arm is used to hold the electrodes. The placement of electrode depends on welding requirement i.e. distance between two successive electrodes. It is simple techniques in which one arm (Lower) is fixed and other arm (Upper) is moving up and down. Pedal arrangement is attached to upper arm by means of spring, damper. The attachment of electrode is variable in vertical axis and it is fixed with the help of locking screw arrangement .it is useful for purpose of adjustments like electrode length is variable. For welding of two rods ,upper arm is inclined to base and at the time of welding, movement of arm is downwards .during welding process pressure, current are important parameter.

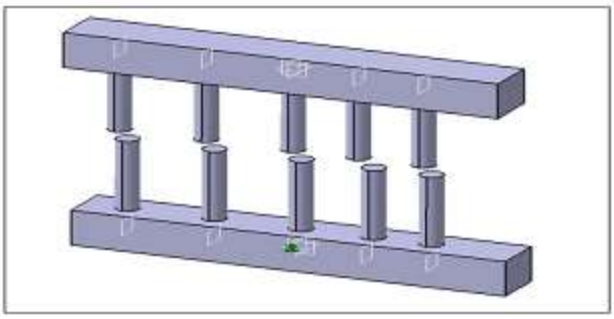

Fig.3 Multi spot electrodes

By implementing these techniques' following Limitations arises:

Limitations:

- Unequal distribution of pressure and force.
- Unequal wear of electrodes.
- Manual force requirement is larger.
- Improper distribution of heat.
- The weld nuggets formed are weak in strength.
- Sometimes excess heat may be flow through electrodes.
- Replacement of electrode is not possible because of high cost.
- Because of Inclination, bending of arm may occur.
- Due to using no. of electrodes, it is time consuming for replacement of electrode.

6.2 Cam And Follower Arrangement:

It is method in which cam is used for rotation purpose and continuous spot is takes place. Cam is used for transmitting motion from electrical motor to the electrode with the help of gear reduction mechanism. Electrical motor is used for rotating output shaft, which is coupled to worm and worm wheel for reducing speed of shaft. This speed is used for actual welding purpose. Cam and follower is used at base of machine. By using follower rotary motion getting converted in to rotary motion. Controller is useful for setting of welding parameter, due to this arrangement following are advantages:

1. No requirement of force

2. The productivity remains constant

6.3 Manufacturing Of Dies:

Manufacturing of die is one of the method in which all spot are done in one stroke. Die are made of cooling arrangement with electrode tip adjustment. Electrode material is copper and it is screw adjustment with die. All electrode tip pointer are attached before put in operations. During the operation of press pedal the moment of upper die is up and down. When it is in down condition all spot are carried out and finalized the product. Placement of electrode is important parameter for welding, hence at the time of starting shift it needs to check by supervisor.

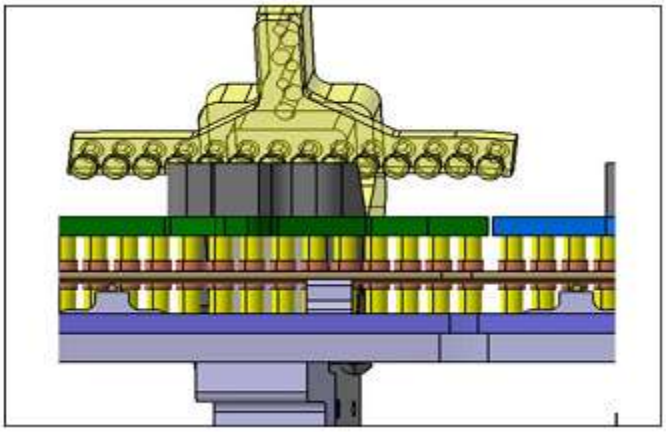

Fig.4 Dies solution

Using this solution, total fifty to fifty two spot are done in one stroke hence it leads to improve productivity. But manual force requirement is larger.

6.4 Development In Electrode (Plate):

It is another method in which, no. of electrodes are eliminated and copper plates are useful for welding. In this technique two plates of 5mm thickness are used to join wire rods. Only one electrode having larger surface area used for welding. The application of force is centralized with the help of cylinder and bearing arrangement .Secondary winding of transformer attached to the copper holder and copper electrode, which is useful for completing the circuit. "Inclination of arm" drawback eliminated with the help of copper holder, it is parallel to wire rods. Linear motion bearing fixed to the upper arm for the purpose of application of pressure to electrodes. This development is able to solve these drawbacks. The requirement of force is negligible as compressed air for its actuation. The advantages are as follows:

- Pressure requirement is less.
- Wear of electrode is less.
- Placement of electrode (plate) is simple.
- Heat distribution is proper due to using of coolant passage.
- Weld nugget strength is equal for every spot.
- Due to surface contact, flatness is maintained.
- Manual force requirement is smaller.

From above four solutions we have suggested, the solution "development of electrode plate" has been selected as a feasible one in order to fulfill the different requirement(productivity, cycle time, operator fatigue). With the help of electrode plate solution some new modifications are done. The electrode plate areas are considered as spacing between two electrodes. The plates are used to weld five spot but machine safety point of view four spot are done at a time.

7. BENIFITS OF MODIFIED MACHINE

7.1Productivity:

Productivity is the ratio of Output (Final finish product) to Input (Raw material).Because of the pneumatic system and used of flat copper welding electrode the operation time is decreases. Quantity of production during each shift increases. Ultimately the productivity increases. The productivity has increases up to 30 to 40 %.

7.2 Operator fatigue:

In a new developed machine, we used pneumatics system to generate the required pressure. This reduced the operator fatigue and stress as well. The work of operator is only to press the pneumatic pedal with minimum force.

7.3 Flexibility in production:

The new machine is more flexible in production. In new machine continuous weld as well as spot at particular area where required is possible. We can use these machines for the continuous welding outer periphery of the part. We can use this machine maximum five spot at one stroke, where required.

7.4 Cycle Time:

Because of use of flat copper welding electrode four spot has been cover in one stroke. Hence time required for finalized the part is reduces, ultimately finalized part strokes are reduced and cycle time is reduced.

7.5 Weld strength:

Because of using pneumatic system we can select required pressure with the help of pressure gauge. Pressure distribution is same in every spot, which increase the quality of weld as well as weld strength.

8.RESULT & DISCUSSION

After applying the Exact solution to the problem we can get following results, which are discussed below,

1. After modification in welding machine for resistance welding the effort of worker for doing the same job. manually are reduce to greater extend, as we are using pneumatically operated pedal arrangement which required less force to operate than previous spring operated pedal.

2. Initially one spot is done at a time now we can have modified machine for multi-spot resistance welding which results into reduce cycle time.

3. As manual force requirement is less and reduced cycle time consequently productivity is also increased.

4. With respect to economy, productivity, cycle time reduction & other requirement of product design; the welding machine we could have modified is suitable for particular application in industry.

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