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"Fabrication of Semi-Automated ARC Welding Machine"

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Abstract **- Automation systems are rapidly taking the place of the human work force. One of the benefits is that this change provides the human work force with the time to spend on more creative tasks. Increased quality requirements for products and the trend to automate production processes along with increased profitability result in the use of automation in modern manufacturing. With the rapid developing of economy, India has gradually become a manufacturing giant in the world. Welding is one of the most important technologies of materials forming and processing in modern manufacturing industry. Welding is the primary connecting process in various constructions. Automated systems play an important role in achieving higher quality and productivity in a cost-effective way. The objective of this project is to reduce the time and cost required for arrangement of Semi-Automated Arc Welding Machine (SAWM).**

I. INTRODUCTION

With ever increasing demand for both high production rates and high precision, fully mechanized or automated welding process have taken prominent place in the welding field. The rate at which automation is being introduced into welding process is astonishing and it may be expected that by the end of this century more automated machines than men in welding fabrication units will be found. In addition, computers play critical role in running the automated welding processes and the commands given by the computer will be taken from the programs, which in turn, need algorithms of the welding variables in the form of mathematical equations. To make effective use of the automated systems it is essential that a high degree of confidence be achieved in predicting the weld parameters to attain the desired mechanical strength in welded joints.

A. Definition of welding:

Welding is a fabrication process to make high strength joint between two or more parts by heating to their melting temperature, with or without the application of pressure and with or without the use of filler metal. The filler metal has a melting point approximately same as the base metal.

B. Classification of welding process:

1. Plastic welding or Pressure welding.
2. Fusion welding or Non-Pressure welding.

1. Plastic welding or Pressure welding:

When the metal piece acquires plastic state on heating, external pressure is applied. In this process, externally applied forces play an important role in the bonding operation. "A group of welding processes which produces coalescence at temperatures essentially below the melting point of the base materials being joined without the addition of a filler metal" is Pressure Welding Process. Without melting the base metal, due to temperature, time and pressure coalescence is produced. Some of the very oldest processes are included in solid state welding process. The advantage of this process is the base metal does not melt and hence the original properties are retained with the metals being joined.

2. Fusion welding or Non-Pressure welding:

The material at the joint is heated to a molten state and allowed to solidify. In this process the joining operation involves melting and solidification and any external forces applied to the system do not play an active role in producing coalescence. Usually fusion welding uses a filler material to ensure that the joint is filled. All fusion welding processes have three requirements: Heat, Shielding and Filler material.

C. Types of welding:

Welding process can also be classified as follows:

1. Gas Welding
2. Arc Welding
   - Carbon Arc Welding
   - Shielded Metal Arc Welding
   - Submerged Arc Welding
   - Metal Inert Gas Welding
   - Tungsten Inert Gas Welding
   - Electro Slag Welding
   - Plasma Arc Welding
3. Resistance Welding
4. Solid State Welding
5. Thermo-Chemical Welding
6. Radiant Energy Welding

- Shielded metal arc welding:

The most common types of arc welding is shielded metal arc welding (SMAW), which is also known as manual metal arc welding (MMAW) or stick welding. An electric current is used to strike an arc between the base material and a consumable electrode rod or stick.

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The electrode rod is made of a material that is compatible with the base material being welded and is covered with a flux that gives off vapors that serve as a shielding gas and provide a layer of slag, both of which protect the weld area from atmospheric contamination. The electrode core itself acts as filler material, making separate filler unnecessary. The process is very versatile, requiring little operator training and inexpensive equipment. However, weld times are rather slow, since the consumable electrodes must be frequently replaced and because slag, the residue from the flux, must be chipped away after welding.

II. FABRICATION

A. Components required:

The major parts in “SEMI-AUTOMATED ARC WELDING MACHINE**”** are described below:

- PIC Microcontroller(Peripheral Interface Controller)
- Relays
- Screw rods
- Welding machine
- Step down transformer
- Bridge rectifier
- Magnetic read switches
- Motor
- Gears (spur, bevel gears)

B. Fabrications of different components:

- Base frame: The base frame as
  Length: 530mm
  Width: 280mm
  Height: 480mm

Figure 1.0: Base frame

- Screw rods:
  Length: 360mm
  Diameter: 20mm
  Pitch diameter: 18mm
- Bench vice:
  Length: 210mm
  Width: 85mm
  Work piece that can be held: 50mm

Figure 1.1: Bench vice

- Gears:
  Bevel gears (2 units): 20 teeth’s each
  Right angled bevel gear is used.
  Spur gears (2units): 30 teeth’s each

- Welding torch holder: The welding torch holder is made of two Iron flanges welded perpendicular to each other and by using a clamp the welding torch is clamped to the perpendicular flange. The other flange is welded to nut on to the vertical screw rod.

Figure 1.2: welding holder

- DC wiper motor: The motor of speed 60rpm and torque 50Nm is rigidly attached to the spur gear which in turn rotates the screw rod with the help of another spur gear. The motor is rigidly fixed to the machine by welding the motor in place. The motor works on 12v voltage and it requires current of 4A.

Figure 1.3: DC wiper motor

- Circuit board: Here the components that we used like relays, step down transformer, bridge rectifier, voltage stabilizer, microcontroller, magnetic reed switch and

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other simple components required to complete a circuit board like diodes, transistor, resistor etc. are soldered together according to our project requirement, a suitable programmer is fed into the microcontroller. Thus the circuit board is completed in order to work as required.

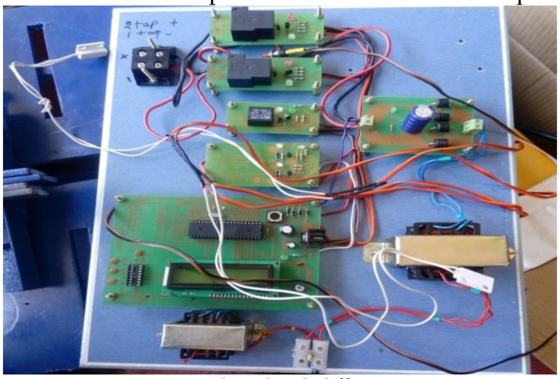

Figure 1.4: Circuit board with different components

- Welding machine:

MODEL	ARC/ZX7-200
RATED INPUT	AC 220+15%
RATED OUTPUT	170A/26.8V
WELDING CURRENT	10−170A
EFFICIENCY (%)	85
POWER FACTOR	0.93
SIZE(mm)	273*120*188
WEIGHT(Kg)	5

Table 1.0: specifications of portable welding machine

C. Assembly:

- The assembly unit consists of two screw rods, a base frame, bench vice, welding torch holder, motor, bevel gears, spur gears, nuts, base plate, magnetic reed switch and circuit board
- First two screw rods are arranged perpendicular to each other i.e. one screw rod parallel to ground and another perpendicular to ground, with the help of two bevel gears.
- Now the bench vice is welded to a nut which is threaded into the horizontal screw rod and the welding torch holder is welded to nut which is threaded to vertical screw rod.
- This arrangement is placed in base frame (L shape), free end of one screw rod is connected to motor with the help of spur gears and the free end of other screw rod is fixed with the help of roller bearings.
- After these arrangements, by calculating the length of welding required the magnetic reed switch is placed on the vertical section of the frame which senses the magnets present on the welding torch holder.
- The electrode is placed in welding holder after sparking the electrode, this process of sparking is necessary in arc welding.

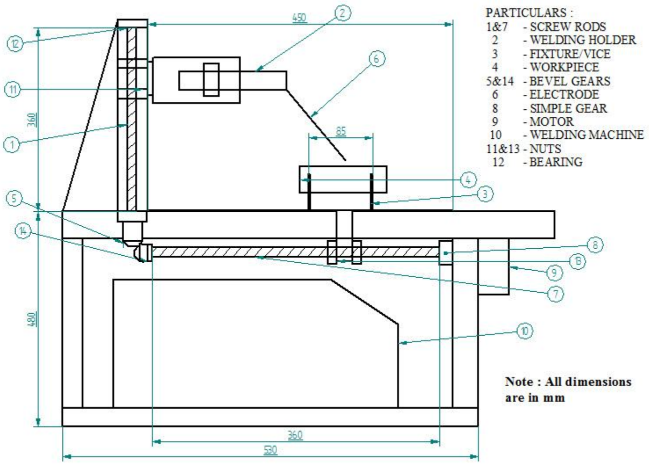

Figure 1.5: 2-D View of experimental setup

III. OPERATING METHODOLOGY

A. Working:

- Now the work piece is placed firmly on the vice in which vice as the movements on the base plate. The vice moves in forward and backward with the help of the screw rod. The movement of the screw rod is initiated by motor.
- The suitable electrode is selected for the process to carry out and electrode is fixed to holder to some defined angle in order to carry to welding process.
- The movement of the electrode holder is controlled by the magnetic reed switches which are placed at top and bottom end of the vertical frame.
- Now the whole setup is initiated by pressing the switch button. The magnetic reed switch at the top of the vertical frame senses magnet which is placed or fixed on electrode holder, so that this magnetic reed switch gives the input to micro-controller which in turn gives input to relay so that motor rotates in clockwise direction.
- This clockwise movement of screw rod helps the vice or job to move in forward path which in turn moves the work piece or job to be welded, and the welding machine is connected to the electrode holder and proper earthen should be given to the work piece or job. The electrode holder along with electrode moves in downward direction to complete the process of welding.
- Once the welding is done the magnetic reed switch at the bottom of vertical plate senses the magnet fixed on electrode holder and gives the input to micro-controller which in turn gives input to the another relay which rotates the motor in anti-clockwise direction thus the vice along work piece moves to the initial position. So with the help of proper connection in the circuit board and proper assembly of all parts we can achieve the process of welding.

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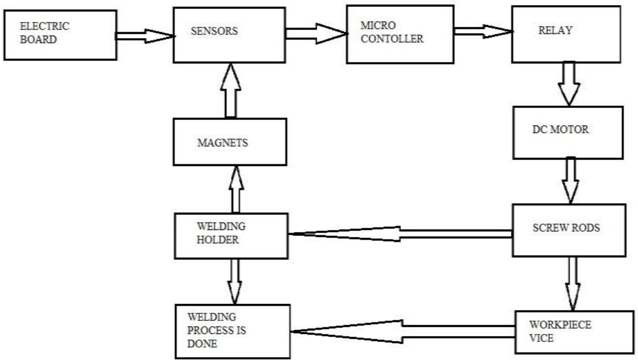

Figure 1.6: Block diagram of working principle

B. Calculations:

1. *Screw rod calculations*:

- Major Diameter = 20mm
- Pitch $= \frac{1}{\text{number of threads per inch}}$

  $= \frac{1}{14} = 0.0714'' = 1.813\text{mm}$

- Single thread height = 0.75*pitch*cos(30)

  = 0.75*1.813*cos30

  = 1.1779mm

- Pitch diameter

  d = Major diameter – single thread height

  = 20-1.779

  = 18.23mm ≅ 18mm

- Area of threaded screw rod (A)

  A = 3.14*length of screw rod*d*1.65

  = 3.14*360*18*1.65

  = 33572.8mm^2

- Torque required to raise the load:

$$T_R = \frac{Fdm}{2}\left[\frac{l+\pi f dm\ Sec(\alpha)}{\pi dm - f l\ sec(\alpha)}\right]$$

Where, F = force to be raised = 7.35 N

dm = mean diameter =18mm = 0.018m

$2\alpha = 30^0$ $\alpha = 15^0$

F = co-efficient of friction = 0.15

L = load distance = 350mm =0.35m

$$T_R = \left(\frac{7.35*0.018}{2}\right)\left[\frac{0.350+(\pi*0.15*0.018*Sec(15))}{(\pi*0.018)-(0.15*0.350*Sec(15))}\right]$$

T_R = 10.8 Nm

2. *Spur gear calculations*:

- Outside diameter = 44mm
- Inside diameter = 40mm
- Number pf teeth = 30
- Pitch diameter $= \frac{\text{outside diameter} * \text{number of teeth}}{\text{number of teeth}+2}$

  $= \frac{44*30}{30+2}$

  = 41.25mm

- Diameteral pitch (P)$= \frac{\text{number of teeth}+2}{\text{outside diameter}}$

  $= \frac{30+2}{44}$

  = 0.727 teeth/mm

IV. RESULTS AND DISCUSSION

SL. NO	Distance welded in cm	Time taken by skilled worker in sec	Time taken by unskilled worker in sec	Time taken by semi-automated machine in sec
1	0	0	0	0
2	5	8	12	10
3	10	12	20	17
4	15	18	27	21

Table 1.1: comparison of time taken to weld by different workers and machine.

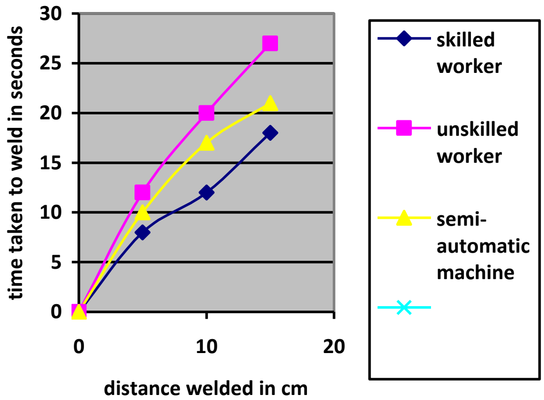

Figure 1.7: graph shows the different time taken by workers and machine to weld.

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Figure 1.8: Final experimental set up ready to connect with circuit board.

A. Conclusion:

The following points are the conclusions drawn from the fabrication of semi-automated welding machine.

1. By the above process and experimentation we have developed “A SEMI-AUTOMATED ARC WELDING MACHINE” which is very useful in small industries and provides safety for the worker.
2. Maximum thickness of work piece (mild steel) the machine can weld is less than 6mm.
3. The maximum length up to which the machine can weld is 150mm and maximum width of the metal piece to be weld is up to 50mm.
4. This would be very helpful in mass production industries having conveyors, MIG and TIG welding and other applications.
5. The commercial production of this project is feasible economically.
6. Semi-automated welding machine takes less time to weld, when compared to the unskilled labor.

Figure 1.9: Bead on plate performed by the semi-automatic arc welding machine.

7. Adopting semi-automatic welding machine is better than opting unskilled labor for welding.
8. Portability - As the total weight of the machine is less than 20Kg, these materials are very easy to transport.

REFERENCES

[1] Anders, A. (2003). "Tracking down the origin of arc plasma science-II. early continuous discharges". IEEE Transactions on Plasma Science. 31 (5): 1060–9. doi:10.1109/TPS.2003.815477.

[2] Oberg, Erik; Jones, Franklin D.; Horton, Holbrook L.; Ryffel, Henry H. (1996), Green, Robert E.; McCauley, Christopher J., eds., Machinery's Handbook (25th ed.), New York, NY, USA: Industrial Press, ISBN 978-0-8311-2575-2, OCLC 473691581.

[3] "PIC17C4x microcontroller data sheet" *(PDF). Microchip Technology. 1996. DS30412C.* Retrieved 2016-08-16.

[4] William H. Yeadon, Alan W. Yeadon. Handbook of small electric motors. McGraw-Hill Professional, 2001. Page 4-134.

[5] US Patent 4,038,620: Magnetic reed switch by B. Edward Shlesinger, Jr. and Charlie Dwain Mariner, July 26, 1977. A switch with one magnetic reed and one non-magnetic one.

[6] ANSI/IEEE C57.13, ANS Requirements for Instrument Transformers. *New* York, N.Y.: IEEE. 1978. p. 4 (§3.26). ISBN 0-7381-4299-9. (superseded, 1993).

[7] Bickford, John H.; Nassar, Sayed (1998), Handbook of bolts and bolted joints, CRC Press, ISBN 978-0-8247-9977-9.

[8] Miller Electric Mfg Co (2013). Guidelines For Gas Tungsten Arc Welding *(GTAW)* (PDF). Appleton, *Wisconsin*: Miller Electric Mfg Co.

[9] Georgi Dalakov. "The electromechanical relay of Joseph Henry".