AUTOMATION OF ELECTRODE PINNING PROCESS

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Abstract - *The electrode and nozzles are the different materials that are assembled into the plasma cutting torch. The manufacturing of these components takes place in CNC machine and later the final stage finishing and developing of these materials takes place. After manufacturing the electrode, a pinning wire has to be inserted in it which is required for cutting action of metal to be cut by plasma torch. The wire is inserted, cut and then punched manually into the nozzle. This operation is done manually till now in which emerges a lot of difficulties such as material wastage, incorrect length of wire, inaccuracy in wire punching.*

***Key Words*: Automation, Electrode, Arduino, Rotary Indexer, Punching.**

1.INTRODUCTION

'ARC WELD EQUIPMENTS PVT LTD' is a well settled company in the stream of manufacturing of welding and cutting Equipments. One of their products is plasma arc cutting electrodes and nozzles, which is used in metal cutting operation. This is a bullet sized and shaped product that is fitted into the plasma torch. This can cut up to 20m length of the metal.

Our objective is to:

- Create a setup fully based on an automated process with very least error.
- Earlier the process was carried out manually and it was not very economical to the company.
- To manufacture the same product with lower cost of production and increasing the overall profit.

We have to develop only the post processes of the electrode and nozzle which will include automation processes like pining, cutting, punching, of electrode and nozzle.

1.1 METHODOLOGY

- Observation of Live Industry Problem and Development of a feasible design solution.
- Preparing the design in a CAD model to demonstrate the solution.
- Taking into considerations the pre-requisites of the company and check list of factors provided by the company (size, ergonomics, etc.)
  - Manufacturing of the Prototype according to the dimensions and according to the sequence of operations to be performed on it.
- Perform testing of pneumatic components, Electronic components and develop a program in Arduino for the synchronization of the setup.
- Trial performance on the setup for 1 month to obtain the required results and for other fault findings and improvements.

2. CAD MODELLING AND DESIGNING

- After Making a list of all the components in the Automation setup, we started developing its 3D model in Solidworks Software**.**
- Individual components were made and then assembly of all the components was done to make the final automation setup.
- Then all the components were projected in 2D, so that while manufacturing it will be helpful.

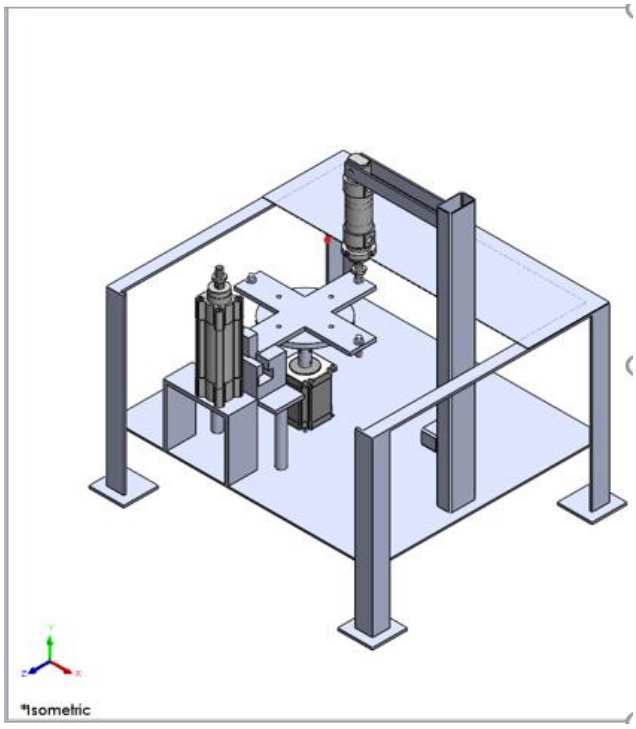

Fig-1 Model Developed in Solidworks

3. COMPONENTS

3.1 Pneumatic Cylinders

For actuation of Cutting, Punching, Wire Insertion we have used Pneumatic actuators controlled with help of 5*2 DC

valves. For operation of all the valves a Reciprocating Air Compressor is used with 8 bar working pressure capacity. We have also used Manifold to connect all the cylinders so that from a single air supply the compressed air will be supplied to all the cylinders.

Fig- 2 Pneumatic cylinder ϕ50*25mm stroke

3.2 Rotary Indexer with Stepper Motor

This is used so that the electrode will rotate by 90 deg at each station so that the required operation will be performed on it. It is controlled with the help of stepper motor (NEMA 23 18.9 kg.cm). We have used stepper motor so that we can get a constant torque due to which the exact degrees of rotation are obtained and accuracy is increased. The electrode needs to be at exact place so that the particular operation is performed accurately. The material used for manufacturing of Rotary Indexer is Mild Steel.

Fig- 3 Manufactured rotary Indexer with detachable fingers

3.3 Two Jaw Gripper with Servo motor control

On the Rotary Indexer to secure the electrode properly while the operations such as cutting and punching takes place it is important that the electrode should not move so that the accuracy of punching and cutting could be maintained

Fig- 4 Aluminum Gripper with MG996R servo

3.4 Arduino Uno with TB-6560 Controller

To control the synchronization of all the operations we have connected all the motors and circuits with the help of Arduino Uno. The programming is done in Arduino and the stepper motor is being controlled by using TB 6560 Stepper motor driver which is able to give correct speed steps even at relatively higher speeds. Its recommended operating voltage is 24 VDC and max current output is 3A per phase, 3.5A peak.

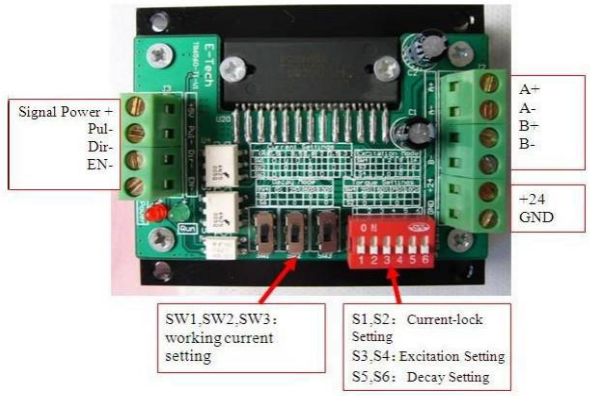

Fig- 5 TB- 6560 controller for stepper motor

4. CONSTRUCTION AND WORKING

4.1 Fabrication of Model

450x450mm wide and 4mm thick plate was required as the material for base plate. And small sized rectangular materials and Sq. pipes were required for further processing. Frame was to be enough stronger to take the load of all the components. The frame hence is taken of 4mm thickness and it is welded 15mm above the ground

level on the L-channel of 2.5x2.5 inches. Later the Sq. pipe was welded over the channel for the punch support and with a small sized sq. pipe in between the vertical length to fix the gripper on it. After welding the base plate and sq. pipes, weld a plate on one of the side of the base plate over the L-channel to fit the DC valve of pneumatics. On each side weld 2mm thick and 5mm wide plate to provide overhead and extra support for further assemblies. A thin and wide plate is cut and bolted over the top on the same side where the DC valves are to be fixed. On this Plate the 10 pin Connector will be attached to act as the mode of connection between power house.

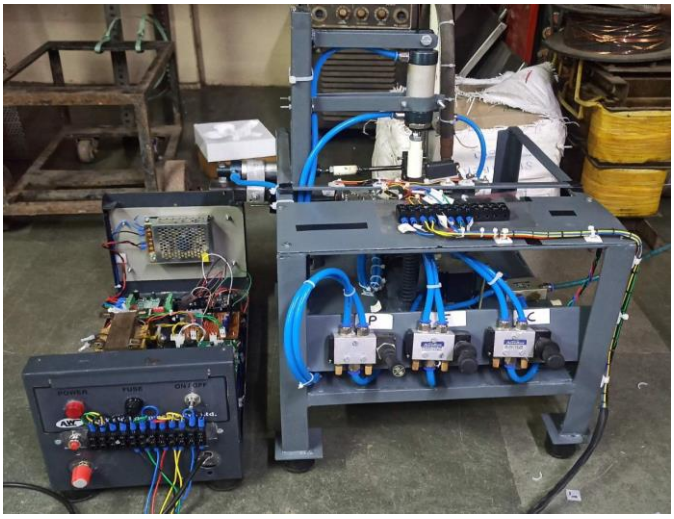

Fig- 6 Actual manufactured prototype setup

4.2 Sequence of Operations Performed

- First the electrode will be loaded at 0 deg
- Then the indexer will be turned by 90 deg using the stepper motor where the gripper will grip the electrode
- Then the wire is inserted into the electrode and cutting of wire according to the given length will be done.
- Again the electrode will rotate by 90 deg where it will be gripped by another gripper and punching of wire inside the electrode will be done by pneumatic action.
- After that the electrode will be rotated by 90deg where it will be unloaded and a new electrode will be loaded on a new station.

5. EXPERIMENTATION AND RESULTS

5.1 Observation of Position for 1 Electrode Only

Sr. No	Position	Operation	Total Time	Cumulative Time
1	A- 0°	Loading of electrode on 0°	2	-
2	B-90°	Feeding and Cutting	18	20
3	C-180°	Punching	7	27
4	D-270°	Unloading	3	30
5	E-360° /0°	Empty finger/ Loading	2	32

Table- 1 Time taken for processing 1 electrode

5.2 Total Monthly Production

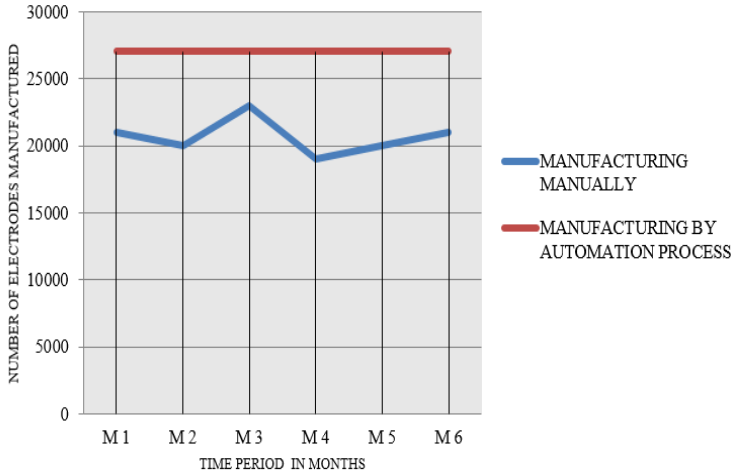

Chart-1 Comparison between manual and Automation process

6. CONCLUSION AND FUTURE SCOPE

6.1 Conclusion

At the end we finally turned our concept into prototype having a real world application. We were successful in designing and manufacturing the whole prototype with minimum machining errors resulting output with better consistency. We have successfully reached to 80 % efficiency, just a bit amount of innovation and upgrade has to be done in cutting section. Also we stood up the promise

made to the company of increased productivity as compared to traditional handy method. The main advantage of automation achieved is that the machines can work the whole shift as compared to worker assigned for the job as the assigned employee would get tired after a certain time slot. The output from the machine had more uniformity as compared to human work as uncontrollable factors such as human errors got neglected.

6.2 Future Scope

Now in our Automation setup still the Loading and Unloading operation has to be done Manually, so it can also be done automatically using Pick and Place Robots. Also the Production Can be increased If the no. of fingers is increased on the Rotary Indexer.

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