Design and Development of Automated Filler Rod Feeding Mechanism for Tungsten Inert Gas Welding

[1]Ronak Patel, [2]Ankit Patel
[1]Student, [2]Assistant Professor
[1]Department of Mechanical Engineering,
[1]Parul University, Vadodara, India.

Abstract: **As we know, Tungsten Inert Gas welding being the most useful joining process for several companies. This joining method is employed for joining stainless steel pipes, parts used in an automobile and also in other manufacturing processes as well. There is an upsurge in usage of this welding process as it gives wear resistant and slag free joints. Presently, in large factories robots are employed for welding but, still there are certain limitations. For small scale productions and where accurate joints are required welding is still done manually. This project aims to reduce human labor in manual welding process with no compromise in accuracy. This paper gives complete information on development of an automated filler rod feeding mechanism for TIG welding.**

***Keywords*: Tungsten Inert Gas welding, Wear Resistant and Slag Free joints, Robots, Accurate joints, Human labor.**

I. INTRODUCTION

Presently manufacturing and production processes are changing exceptionally with a main aim that How to reduce the human intervention's? Along with, improved accuracy in an operation. The above, mentioned aim can only be achieved by using robots and automatic machines. For achieving automation various means can be used like mechanical, electrical, pneumatic, hydraulic, and in some cases using electronics. In certain machines they work in combination for instance automation achieved by using mechanical and electronic devices. The prime objective behind employing this remains the same as earlier mentioned but also, includes saving electricity and material costs.

In this joining process electrode does not change its shape like in other welding methods but, here joining is done by heat which is generated between the two workpieces which might be similar or dissimilar based on the need and an electrode. Enormous amount of heat is generated due to motion of charged ions and electrons. Non consumable electrode, shielding gas, filler material and welding machine is required for this joining process. Shielding gas prevents air contamination and oxidation as this gas being transparent worker can easily see an electrode. Filler material is used for providing better arc. For constant supply of electric current welding machine is used which provides constant voltage without any change with these various types of power supplies are used as per the requirement namely direct current straight polarity, direct current reverse polarity and alternating current.

II. PROBLEM DEFINITION

While doing TIG welding one needs to be multitasker as you are feeding filler material using one hand and holding electrode in another hand. A high quality TIG weldments are only carried out by skilled worker as it requires continuous uniform feeding of filler rod which cannot be achieved by semiskilled or unskilled worker.

III. LITERATURE SURVEY

Firstly, I read various research papers for gathering information about the present inventions regarding TIG welding. After gaining valuable information from the papers I looked for the automatic TIG welding machines which are presently employed in industries. Furthermore, gathered information is analyzed for solving the problem and coming with an innovative solution.
Based on the literature survey and analyzed data a demand list is made:

1. Should have continuous as well as dynamic feeding arrangement [1]
2. One can use filler rod of different diameters as per the requirement [2]
3. One can change wire feeding angle [2]
4. Less costly
5. One can use filler rod as well as filler wire as per the need [3]

IV. METHODOLOGY AND COMPONENT STUDY

Methodology comprises of brainstorming for designing proper mechanism as per the demand list and information about the components used in making a mechanism. For fulfilling continuous as well as dynamic feeding requirement interdisciplinary solution was chosen that is by merging mechanical, electronics and computer science discipline. For using different diameter filler rod an arrangement is made which can go to and for past the feeding unit. For changing filler wire insertion angle, two separate modules are made one is handle and the other is feeding unit both connected by nut and bolt assembly. For using filler wire as well as filler rod pulley like system is designed.

Components used are as follows:

1. Servo motors
   Servo motor holds the rollers between which filler rod / wire passes. Reason behind choosing servo motors is that they are light in weight.

2. Microcontroller
   Microcontroller is used for controlling various functions. Here, Arduino UNO is used as a microcontroller as it can be used on any platform such as Windows, Mac OSX, and Linux. Apart from this, one can easily code programs by using it as its programming level is of beginner level.

3. Potentiometer
   Main function of potentiometer is to divide voltage. 100k potentiometer is used in this mechanism as it gives exact value of potential difference across any two points in a circuit also, it never draws current from circuit.

4. Transistor
   Its main function is to amplify electronic signals along with electrical power. Transistor C2625 is chosen as it operates over lower voltage for better safety during welding operation also it has extremely long life and lower cost as well.

5. Resistor, LED, Switches, Push Button and Small Breadboard

4.1 Circuit Diagram

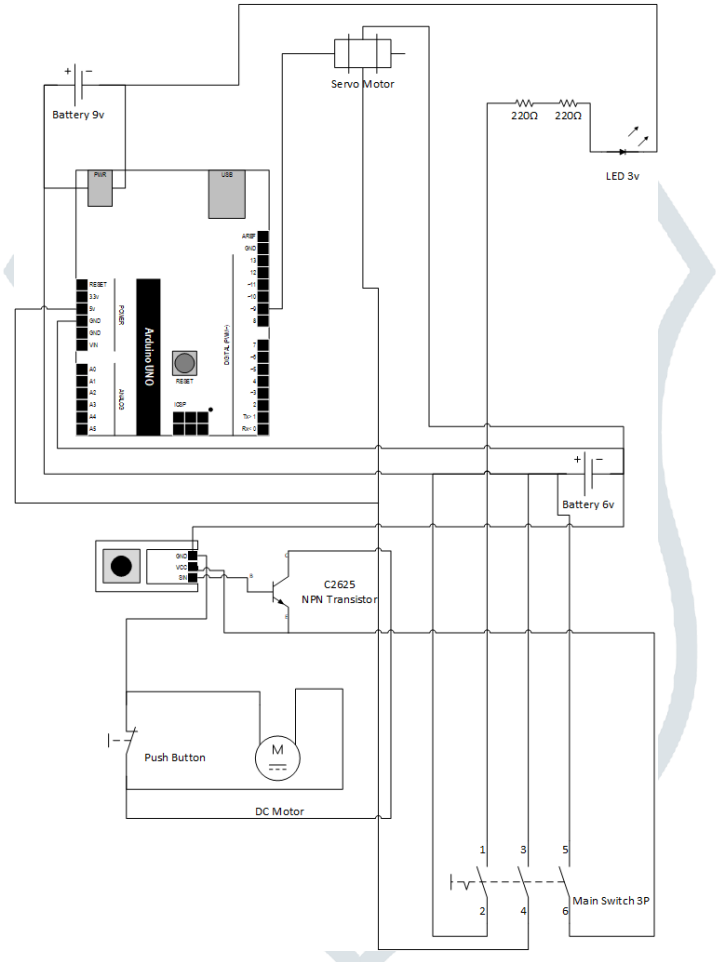

Fig.1. Circuit Diagram

Circuit comprises of 3 flow paths:

1. For ON / OFF (Switch terminals 1-2)
   In the following path for indicating circuit condition emitting diode is provided with resistors joined in series for supplying voltage of 15v.

2. For Dynamic feed (Switch terminals 3-4)
   In dynamic path supply voltage of 9v is supplied for running microcontroller and 6v for servo motor. Servo motor has three terminals from which GND is connected with negative supply, VCC with positive supply and the remaining terminal is used for signal flow.

3. For Continuous feed (Switch terminals 5-6)
   In this path 100k potentiometer is connected with transistor C2625 with supply voltage of 6v for running DC motor. Reason, behind using potentiometer is that it controls voltage so one can vary feeding speed by just turning a knob.

4.2 Arduino Programming

4.2.1 Algorithm for Equal feeding

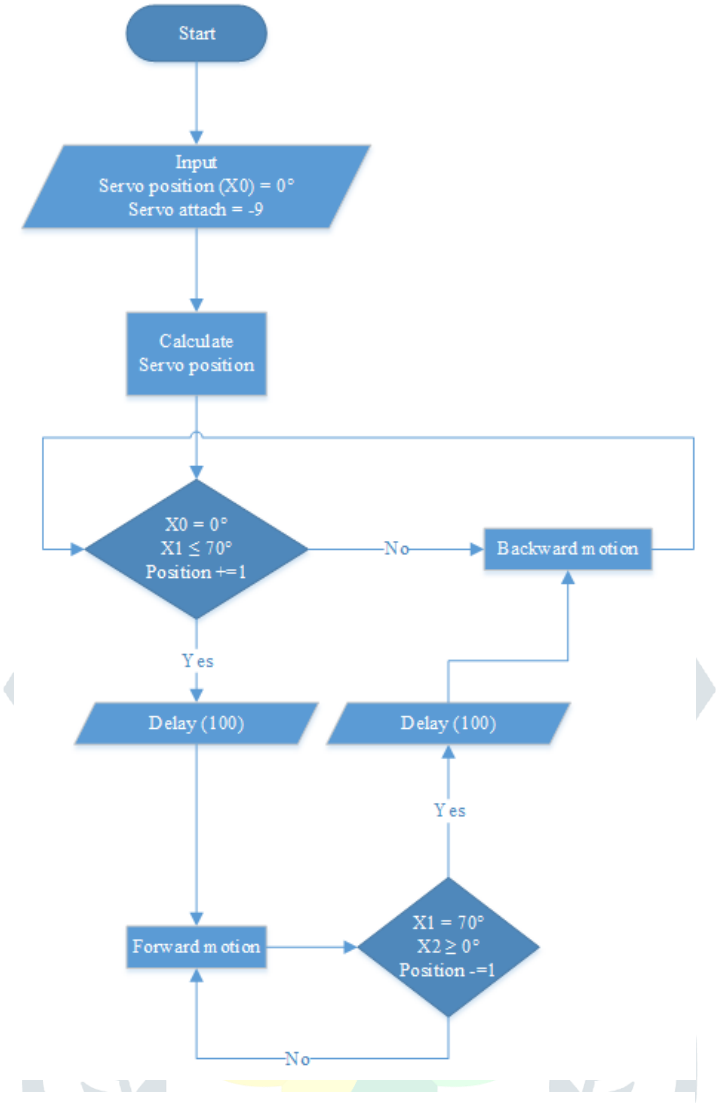

Fig.2. Algorithm for Equal feeding

As shown in algorithm the program begins with providing servo position and servo attached pin number after this it moves for calculating present servo position. After this, decision parameter comes where 1st condition is checked that servo position is between 0° to 70° and if yes then delay cycle starts leading to forward motion but if answer is no it completes backward motion until it reaches the specified degree. Moving further, 2nd condition is checked that whether present servo position is between 70° to 0° if yes then return stroke takes place and if no then it means forward stroke is still running yet not completed. In the end return stroke loop continues by checking condition 1st and the new loop begins.

In this program one can change servo starting position and delay. As per the need, starting position can be changed between 10° to 180°. Below mentioned table 1 is for reference for filler wire insertion in the arc in terms of its length.

Also, there is a provision of changing delay. Delay means time spent in completion of loops. For instance: delay (10) shows fast speed cycle, delay (100) shows medium while delay (1000) shows slow speed cycle. One can also make quick return mechanism i.e. by providing delay of 100 seconds for forward stroke and 10 second for return stroke.

Table1 Angle and Lead Relationship

Angle (°)	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150	160	170	180
Lead	0.7	0.75	0.8	0.85	0.9	0.95	1.00	1.05	1.1	1.15	1.2	1.25	1.3	1.35	1.4	1.45	1.5	1.55

4.2.1.1 UNO Program for Equal feeding

```
#include<Servo.h>

Servo name_servo;
int servo_position = 0;

void setup ()
```

```
 {
  name_servo.attach(9);
}

void loop ()
 {
  for (servo_position = 0; servo_position <=70; servo_position +=1)
 {
    name_servo.write(servo_position);
    delay (100);
  }
  for (servo_position=70; servo_position >=0; servo_position -=1)
{
    name_servo.write(servo_position);
    delay (100);
  }
}
```

4.2.2 Algorithm for Progressive feeding

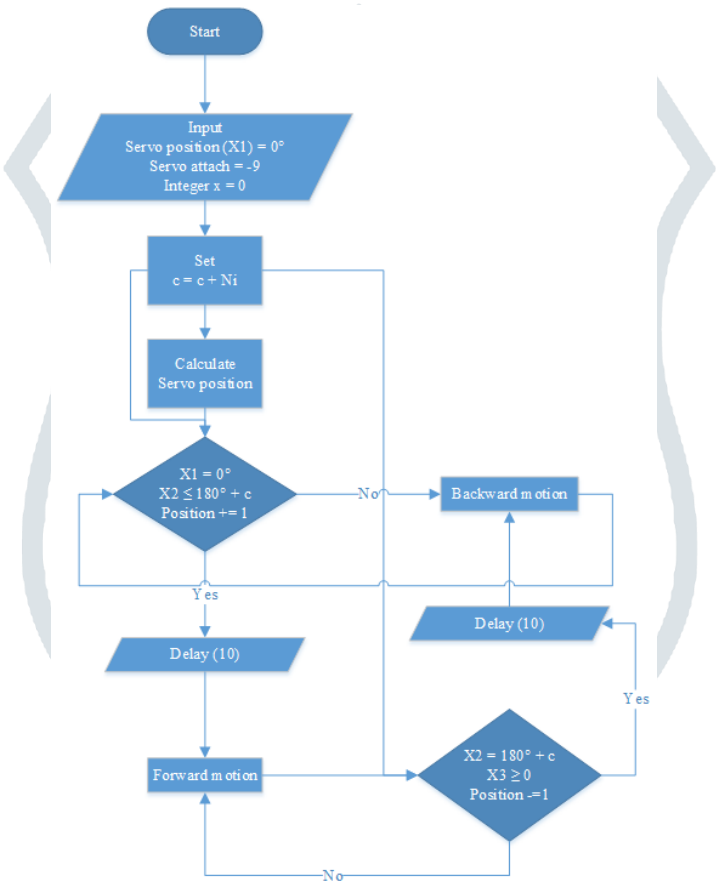

Fig.3. Algorithm for Progressive feeding

This program differs from the former one in terms that in this program feeding increases as per progression series. In the algorithm Ni means lead to be increased and decreased in each forward and reverse pass respectively i.e. the pass increases by and decreases by 1 as set, one can also change it as per the requirement.

4.2.1 UNO Program for Progressive feeding

```
#include<Servo.h>
Servo name_servo;
int servo_position = 0, c=0;

void setup ()
 {
name_servo.attach(9);
delay (10);
}
```

```
void loop ()
 {
for (servo_position = 0; servo_position <=180+c; servo_position +=1)
{
name_servo.write(servo_position);
delay (10);
}
for (servo_position=180+c; servo_position >=0; servo_position -=1)
{
name_servo.write(servo_position);
delay (10);
}

c=c+6;
}
```

V. WORKING

The feeding unit consists of rollers through which filler rod or filler wire passes. Rollers are fixed on servo motors for controlling filler rod speed into the weld pool for continuous feeding. For attaining continuous feed servo motors are controlled by potentiometer. Speed adjustment knob is adjusted as per the requirement. In case of dynamic feeding servo motor works as per the UNO program providing forward and backward motion by controlling an angle made by a servo and by controlling a time that is for how much time filler rod would be inside and outside the pool. The UNO program has an added advantage that it can be changed as per the need for instance if one wants a lead of one centimeter in every forward feed the corresponding angle is 70° but, if the needed lead is of one and a half centimeter than the angle is changed to 170° for more details see table 1.

VI. MECHANISM PICTURES

Fig.4. Controller Box

Fig.5. Feeding Unit

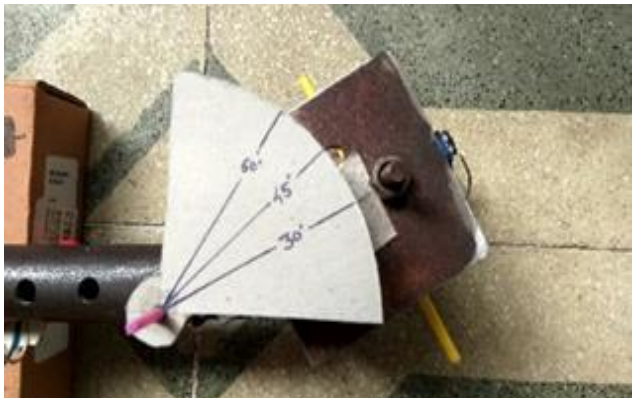

Fig.6. Filler wire insertion at 30°

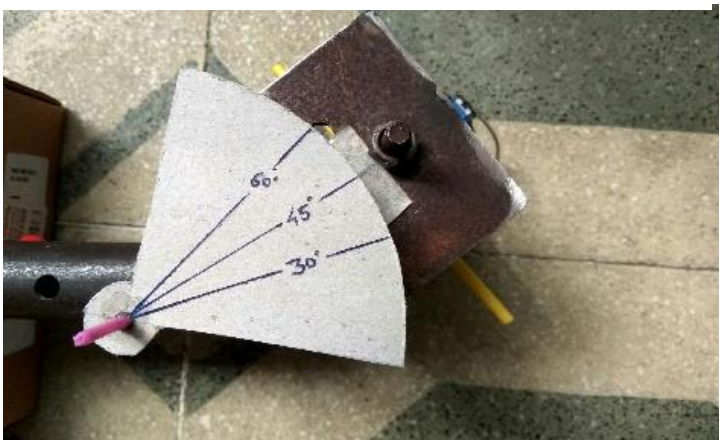

Fig.7. Filler wire insertion at 45°

VII. TESTING RESULTS

Material Specifications
Specimen Diameter-150mm
Specimen Material-Stainless Steel

Filler Material-ER308

By using this mechanism uniform weld with uniform coat was obtained. Weldment obtained by using this feeding mechanism has been approved by Shivshakti Engineering Works. Weld joint obtained by using this feeding mechanism is seen in the following figure.

Fig.8. Welded Joint

VIII. REFERENCES

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