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DESIGN AND CONSTRUCTION OF HYBRID ARC WELDING MACHINE

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ABSTRACT

Hybrid arc welding machine is designed to serve with an input current ranging from 40-50Amps from AC power supply mains and 100AH 24VDC battery. The primary side through which voltage is supplied to the machine has 220 turns which is made of 2.38mm with equivalent standard wire gauge of 13 copper coils. The secondary side is connected to a rectifier with 24 turn made of 3.09mm with equivalent standard wire gauge of 8 copper coil. Both turns are wound on a limb of the laminated core. The voltage from primary turns flow to the secondary turns by induction. The welding current is adjusted when the variable resistor knob is rotated clockwise; the magnetic flux leakage and the inductive impedance are brought down causing the welding current to rise. Also at DC batteries power supply, an inverter circuit was designed. The inverter is connected with an oscillator to provide a frequency of 50Hz for the machine used in welding. The materials and equipments use include copper wire, bending machine, pliers, filling machine, screwdriver, soldering iron, lead sucker, tester and multi-meter. The locally constructed hybrid arc welding machine is capable of producing 20Amps arcing current during welding both on AC and DC source with 220V and 24VDC 200AH batteries respectively. At the end of this construction, there were no challenges observed in the power quality problems and the leakage of the welding transformer. This is because this paper focuses on the design and construction of a dual source arc welding machine putting into consideration quality laminating sheets as well as its thickness. This constant current supply desired to solve the power quality problems. At the end of this construction, it shows that the higher the turns, the more efficient the transformer and more the arcing produced. These attributes shows huge success.

Keywords: Dc source, Ac source, Primary coil, Secondary coil, Current, Welding, Oscillator circuit

1. INTRODUCTION

Welding is a fabrication process that joins materials usually metals or thermoplastics, by causing coalescence. Generally, most of the weldable common steels are preferred to be joined by welding method (Ibrahim, 2016). It is evident that welding is the principal industrial process used for joining metals. However, it can produce dangerous fumes that may be hazardous to the welder's health. Presently, 1–2% of workers from different professional backgrounds (some 3 million persons) are subjected to welding fume and gas action. In confined spaces, welding can be deadly, as without proper ventilation, toxic fumes and gases can be much more intense, and possibly over the respective limits for toxic substances (Kikani, 2016). It can also be used to cut or separate jointed metals. Welding is basically achieved during the early or pre-historic days by heating two metals strip to redness until they become almost molten before bars strip or plate are hammered together. Welding can also be used to join pipes in pipelines, power plant at the construction sites and in home appliance (Ovbiagele, 2015). The Arc welding machine is the type that uses an electric power as an input, which is being supplied through the primary and then transferred to the secondary winding by induction which can be used to carry out welding work by connecting to the output terminal the welding cables (Asiwe, 2018). All welding power supplies transform relatively high-voltage, low-current incoming power to lower-voltage, high-current welding output using a transformer. In the past the transformer operated directly from 50- or 60-hertz incoming alternating current (AC). At these frequencies, a lot of heat is generated in the transformer, so it must be relatively large and heavy. Additionally, if 60 Hz is used, control signals are limited to being issued at no more than 120 per second. Inverters were introduced into welding power supplies first to generate direct current (DC) and later to generate AC. In these power supplies, incoming 50- or 60-Hz AC power first is rectified to DC and filtered and then is fed into the inverter section of the power supply, where solid-state controls switch it on and off at frequencies as high as 20,000 Hz, effectively converting it back to high-frequency AC. This pulsed, high-voltage, high-frequency AC then is fed to the main power transformer, where it is transformed into low-voltage, 20,000-Hz AC suitable for welding. Finally it is put through a filtering and rectifying circuit to obtain DC welding current. Output is controlled by solid-state controls that modulate the switching rate of the switching transistors. Because the power transformer runs at 20 kilohertz, it is much more efficient than one that runs at 60 Hz. This means the transformer can be much smaller and lighter, so the power supply itself can be lightweight. Inverter-based DC gas tungsten arc welding (GTAW) power supplies typically weigh 30 to 50 pounds. With some of these power supplies, the current draw at 205amps is 29 amps on 230-V, single-phase power. While the resulting cost savings of an inverter power supply often are overstated, annual power supply savings typically are 10 percent of the power supply purchase price. Inverter power supplies also "chop up" the incoming AC very finely, resulting in a steady DC without the typical 60-Hz ripple and a stable welding arc (Frank, 2003).

2. OBJECTIVES.

The basic objective of this design is to produce an arc welding machine which operate on an input voltage of 140V/220V with a current range between 40-110Amp which could be used in both industrial and domestic sector for quick and joining of metals.

However, the main objectives are as follows:

- To produced a dual arc welding machine (for both AC and DC supply system).
- Use of hybrid welding process can create sustainable environment.
- To have an arc welding machine that is more efficient which produce neat welding

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3. METHODOLOGY

The approach to this design is realized through the design and construction of its DC input control unit and AC input control unit to give a step down output. The welding of a metal occurs when the control unit and the output system links together through conductive objective to be welded. This aspect has to do with the step and procedure taken to achieve the aim and objectives of the work.

Principles Applied in the design

The principles applied in this paper are based on engineering concept. However, the value and parameters used were determined based on mathematical logics and proven formula.
These principles are listed below

- The mutual induction principle in electromagnetic coupled coils. $M = \frac{\mathrm{N2\phi1}}{\mathrm{I1}}$ as applied in the transformer.
- The ohm's law of resistance: V=IR as applied in selection of the size of conductor and determination of current carrying capacity.
- The turn's ratio formula of a transformer for determination of induced e.m.f in this paper. It is applied in transformer as $\frac{\mathrm{NI}}{\mathrm{N2}} = \frac{\mathrm{E1}}{\mathrm{E2}} = \frac{\mathrm{I2}}{\mathrm{I1}}$
- Mode of heat transfer: heat produced V^2f therefore $V_2^2f_2 = V_1^2f_1$. It is also applied at the point of arcing (i.e welding when metal are jointed of joined together).
- The Kichoff's law of current in a circuit where current enters and leaves a point designated, it is given as EI = 0 i.e. $I_1 + (-I_2) + (-I_3) + (-I_4) = 0$ as applied in the point of arcing.

Block Diagram

This block diagram is a handy tool which depicts the hierarchy of how the transformer, oscillator (SG3524), inverter sub-circuits will interact and interface with each other. The output was achieved through the implementation of the inverter from DC input and or from AC input supply (Figure 1).

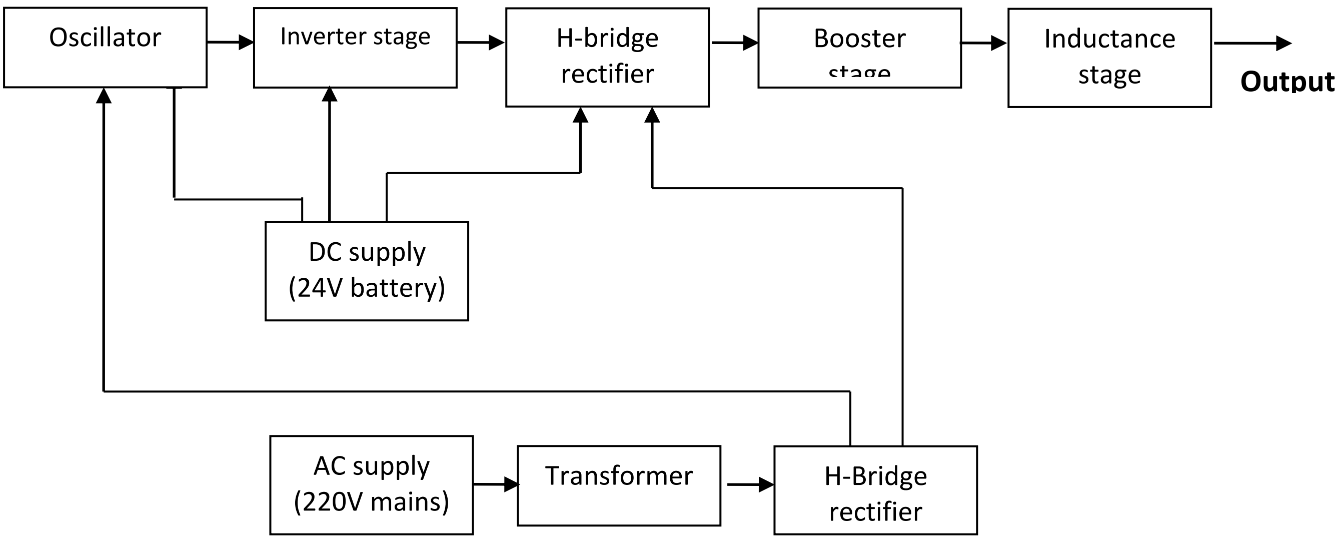

Figure 1: Block diagram

Design procedure

Power Stage: In this stage AC and DC power supply is use. The DC batteries supply the inverter which comprises of power amplifier and converter circuit with necessary voltage. 24V battery is use in this design to power the circuit while using DC supply mains. Also in respect to AC power supply, 220V is fed to the transformer which then steps down to 24V. In addition, it supplies the oscillator and rectifier circuit to give a meaningful output through an inductance.

To supply the electrical energy necessary for arc welding processes, a number of different power supplies can be used. The most common classification is constant voltage power supplies.

Oscillator Stage: An IC SG3524 was use to generate the necessary pulse needed to drive the MOSFET (IRPO64) to convert the DC supply. The output of the oscillator was amplified using transistor (C9014). The frequency at which the circuit operates is determined with the oscillator stage.

Inverter: This unit converts the DC input to the required AC voltage

Transformer: This is the first stage at AC main power supply. A transformer style welding power supply converts the high voltage and low current electricity from the utility mains into a high current and low voltage (typically between 50volt and 10 to 20Amps). A rectifier is used to convert AC into DC to obtain dc output. By moving a magnetic shunt in and out of the transformer core helps to vary the output current. A series inductor to the secondary controls the output current from a booster circuit through the transformer winding. The transformer may also have significant leakage conductance for short circuit protection in the event of a welding rod becoming stuck to the workforce. The leakage inductance may be variable so that the operator can set the output current.

Booster stage: This is coupled with two capacitor (4700/400V) x 2, which help to provide the required current needed by the machine to ensure smooth welding.

Inductor: This is used by the machine to ensure free flow of flux in order to have a smooth welding.

Schematic Diagram of whole Project

Figure 2 shows the schematic diagram of the how the components interact with each other.

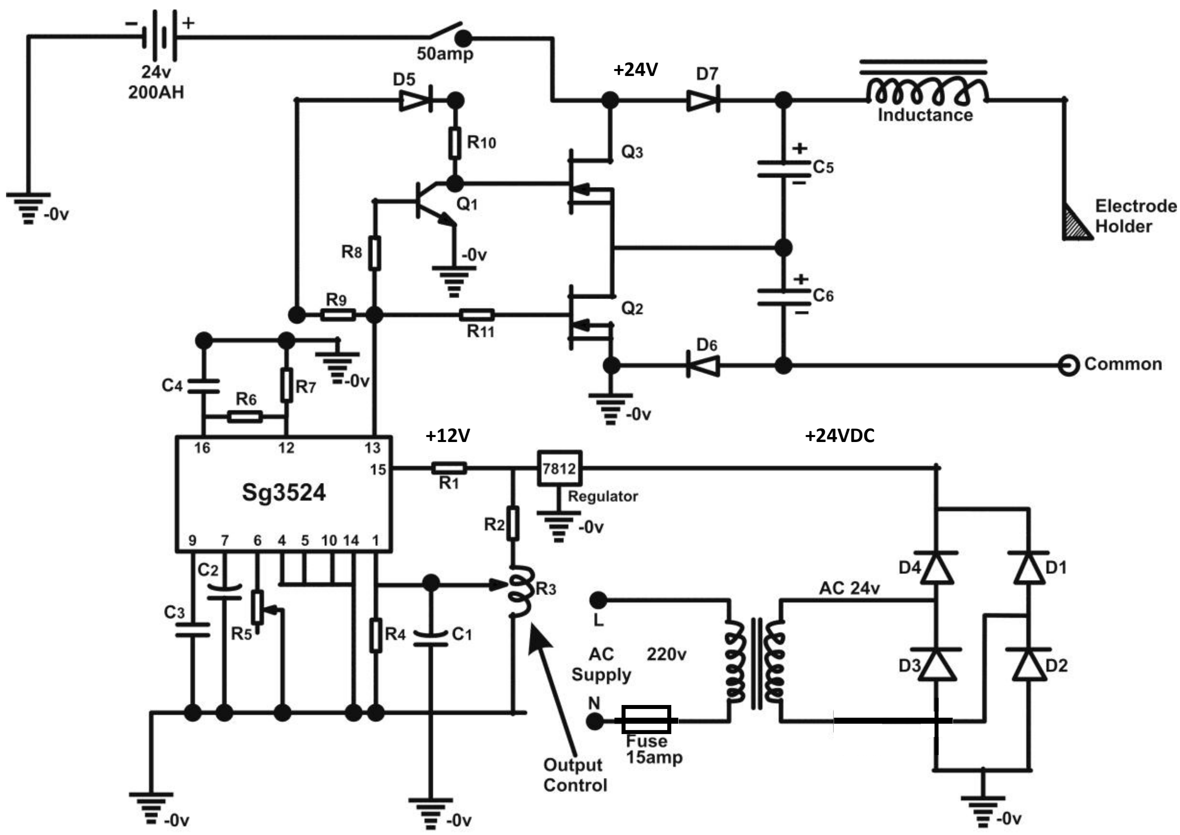

Figure 2: shows schematic diagram of the work

Determination Design Value Using Schematic Diagram and Preliminary Assumption

Welding transformers are designed upon the nature of welding operations. In an arc welding machine electric discharge is uses for welding. This discharge is known as an arc.

Design Specification

The following assumption were made

Volts per turn factor	K	=	0.45
Current density	J	=	6 A/M
Stocking factor	k_S	=	0.95
Maximum flux density	B_m	=	1.2 Tesla
Window space factor	kW_s	=	0.4
Lamination thickness	D	=	0.012
Iron space factor	K_o	=	0.65
Primary voltage	V_1	=	220V
Secondary voltage	V_2	=	24V
DC input voltage		=	24V
Frequency	F	=	50Hz
Secondary current	I_2	=	10A-50A
DC input current		=	20A
KVA rating	S	=	5KVA

Determination of Project Parameter Values and Quantities

Determination of volt per turn

The KVA rating (S) = 5KVA

Hence

$E.M.F\ Per\ turn\ (ET) = k\sqrt{s} = \frac{V1}{N1}$ (1)

$Where\ k\ is\ a\ constant$

$N_1\ is\ the\ number\ of\ primary\ winding\ turns$

$V_1\ is\ the\ primary\ voltage$

$Therefore\ E_t = 0.45\sqrt{5} = 1v/turn$

Number of turns per winding

Using this equation

$N_1 = \frac{E.M.F.of\ the\ primary}{E.M.F\ per\ turn} = \frac{V_1}{E_t} = \frac{220}{1} = 220\ turns$

$\frac{N_2}{N_1} = \frac{E_2}{E_1}$ (2)

Where N_2 is the secondary turns

$E_2 = \frac{N_2\ x\ E_1}{N_1} = \frac{24\ x\ 220}{220} = 24v.$

Cross section area of primary winding conductor

$G_1 = \frac{L_1}{J} = \frac{25}{6} = 4.17mm^2$ (3)

Where L_1 is the lower bound of the secondary current

J is the current density

The diameter = $\sqrt{\frac{G\ x\ 4}{\pi}}$ = $\sqrt{\frac{4.17\ x\ 4}{3.14}}$ = 2.38mm (4)

The equivalent gauge of the primary winding copper wire, which is the standard wire gauge (SWG) = 13 gauge.

Similarly (G_2) cross section area of the secondary winding conductor

$G_2 = \frac{L_2}{J}$ (5)

Where L2 is the upper bound of secondary current

$G_2 = \frac{L_2}{J} = \frac{45}{6} = 7.55mm^2$

The diameter = $\sqrt{\frac{G_2\ x\ 4}{\pi}} = \sqrt{\frac{7.5\ x\ 4}{3.14}} = \sqrt{9.55} = 3.09$mm (6)

Also the equivalent gauge of the secondary winding copper wire, i.e standard wire gauge (SWG) 8 gauge

Core design

The ferromagnetic materials are usually used for transformer core because of their relative permeability and other physical properties. The chosen of core material in this case is mild steel, obtained from old transformer which is still in good working condition and also have the capacity of absorbing heat.

$Using\ \frac{E_1}{N_1} = 4.44\ FB_mA_T$ (7)

$1.48 = 4.44\ x\ 50\ x\ 1.2A_T$

$A_T = \frac{1}{4.44\ x\ 50\ x\ 1.2} = 3.8cm^2$

Where A_T is the cross-section area of the iron core but the cross section area of the core is directly proportional to the square of the stock length i.e.

$A_T \propto L^2$

$A_T \propto QL^2$

Where Q is the constant proportionality and is about 0.15 for a single phase transformer.

$A_T = QL^2$

$$L = \sqrt{\frac{A_T}{Q}} \quad (8)$$

$$= \sqrt{\frac{3.8}{0.15}} = 5.03m$$

$$A_T = \frac{K_O\ x\ K_S\ x\ \pi x D_O^2}{4}$$

Where D_O is the core circle diameter

$$D_o^2 = \frac{4AT}{K_O K_S \pi} \quad (9)$$

$$D_0 = \sqrt{\frac{4\ x\ 0.0038}{0.65\ x\ 0.95x3.142}} = 0.0885m$$

$$D_o = 8.85cm$$

Window Width (W) = 0. 50 X 10.65 = 5.33cm

Window Area

The window area was determined as follow;

$E_1 = 4.44FmN$ (10)

$E_1 = 4.44\ F\ B_M\ A_T\ AW\ KW_S\ {}^J/_N\ X\ {}^1/_2{}^N$ (11)

$E_1 = 2.22\ F\ B_M\ A_T\ AW\ KW_S\ J$ (12)

Where

AT = Cross sectional area of the core

AW = Window area

BM = Maximum flux density

F = Frequency

KW_S = Window space factor

J = Current density

$$AW = \frac{KVA\ x10^{-3}}{2.22\ FB_M\ A_T\ KW_S\ J} \quad (13)$$

$$AW = \frac{5\ x\ 10^3\ x\ 10^{-3}}{2.22\ x\ 50\ x\ 1.2\ x\ 0.0038\ x\ 0.4\ x\ 6} = 4.12m^2 = 41.2cm^2$$

The window area = $41.2cm^2$

Stack Height

Since the cross-section area of the core is directly proportional to the square of stack length or height.

i.e. $A_T \propto L^2$

$A_T \propto QL^2$

Where Q is the constant proportionality and is about 0.15 for a single phase transformer.

$$A_T = QL^2$$

$$L^2 = \frac{A_T}{Q}$$

$$L = \sqrt{\frac{A_T}{Q}}$$

$$L = \sqrt{\frac{3.5}{0.15}} = 5.03m$$

Number of Lamination

The number of lamination was calculated as follows

$$Number\ of\ laminations = \frac{Height\ of\ stack}{Thickness\ of\ one\ lamination} = \frac{5.03}{0.012} = 419 \quad (14)$$

Therefore the number of lamination was 419 vertical.

Design of an Oscillator Using Sg3524

R_5 and C_2 connected at pin 6 and 7 of the IC SG3524 respectively determine the frequency of oscillator. Using equation below we determine the value of the unknown parameter.

$$f = \frac{1.18}{C1C2} \tag{15}$$

Assume $C_2 = 104 \times 10^{-12}$F and the require frequency F=50Hz

Therefore $C_1 = \frac{1.18}{104x10^{-12}x50} = 226933F$

The IC SG3524 is used in the inverter. The IC is used to generate the 50Hz frequency required by the inverter. A DC supply is given to the pin 15 of the SG3524 through Regulator. The pins 4,5,10 and 14 are connected to the negative terminal of the battery. The pins 6 and 7 are the oscillation section pins. The frequency produced by the IC depends on the value of the capacitor and resistor connected at these pins. The capacitor (104pf) is connected to pin 7. This capacitor decides the 50Hz frequency output by the IC. Pin 6 is the timing resistance pin. The resistance at this pin keeps the oscillator frequency constant. A preset variable resistor (10K) is connected to ground from pin 1 of the IC. This preset is used so that the value of the output current can be adjusted to a constant (40-50amps). A fixed resistance of 4.7K is connected in series with the variable resistor as shown by the relation.

Let $R_5 = R_T$ and $C_2 = C_T$

$$f = \frac{1.30}{\mathrm{R5C2}}$$

Where f is the frequency in Hz, R_T is the total resistance at pin 6, and C_T is the total capacitance at pin 7.

Therefore, to obtain a frequency of 50Hz

Given C_T = 104pf

$R_T = \frac{1.30}{104x10^{-12}x50} = 250000k\Omega$

Therefore, R_T must be varied at 100k to obtain a frequency of 50Hz. In our design we used a variable resistor of 100k.

Signals generated at the oscillator section of the flip-flop section of the IC. This section converts the incoming signals into signals with changing polarity in this signal, changing polarity means when the first signal is positive, the second would be zero and when the first becomes zero, the second would be positive. To achieve a frequency of 50Hz, this process most repeat every 50time per second i.e a pulsating signal with 50Hz frequency is generated inside the flip-flop section of the IC.

This 50Hz frequency alternating signal has an output at pin 13 of the IC. Since the reference voltage for the error amplifier (pin2) is set to 2.5V using voltage divider.

Therefore voltage supplied to pin 1 said to be 2.5V.

Using voltage divider

Assume R7 = 4700

$$\text{Vpin 1} = \text{Vout}\ x\ \frac{R7}{\mathrm{R7+R4}}$$

Vpin 1 = 2.5V

$$2.5 = 5\ x\ \frac{4700}{4700+\mathrm{R4}}$$

R4 = 4700 or 4.7kΩ

$$\text{Vpin2} = Vout\ x\ \frac{Rs}{\mathrm{Rs+R2}} \tag{16}$$

Rs = R_5, not that Vout is positive value which is equals 12v in our design. Require

voltage at pin 2 equals 2.5V
Assume R_2 = 1kΩ

$$Rs = \frac{Vpin2\ x\ Rs}{\text{Vout+Vpin2}} \tag{17}$$

$$Rs = \frac{2.5\ x\ 1000}{12 - 2.5} = 2.631\Omega$$

Taking preset R_3 as 10kΩ R_2 = 0.631kΩ.

Elaborate Design of Project

Once the load has been established in the transformer then the current demand in the secondary and primary coil is established.

Primary coil: This is so designed so that it has a lager turn ratio as compared to that of the secondary for the needed current output. The coil is of smaller diameter of 2.35mm (i.e. gauge 13)

Secondary coil: These are of larger diameter of 3.15mm (i.e. gauge 8) and smaller in quantity, this is connected to the load where the high current demanding arc is needed. The coils are well laminated and insulated to avoid losses of energy inform of heat. (i.e. eddy current losses, hysteresis, etc.)

Transformer core: In this aspect of construction, mild steel sheets are cut into desire shape (E) and size based the designed specification. This may also involve the determination of the required number of lamination, these lamination are insulated from each other by a light coat of core-plate vanish to reduce the eddy current losses. The laminations are then clamped together with bolt and nuts. They are made to be tight so that vibration can be reduced to the barest minimum. The thickness of the laminations used is 0.25mm for frequency 50Hz, the laminations are assembled as shown below.

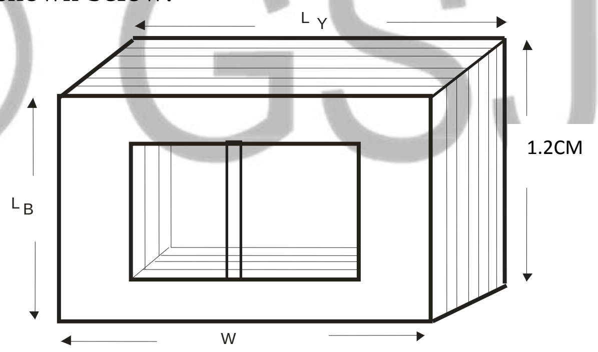

Figure 3: Lamination core

Controller Knob: This was designed in such a way that it can enable one to rotate the knob clockwise to obtain the desire amperage.

Indicator Lamp: This gives a signal light were the machine is connected to a supply mains.

Fan: The fan is connected to the machine to look the temperature. It gets started once the machine is connected to any of the supply mains.

Transformer Assembly

This whole lamination yoke were cut using a small cutting machine, this was done by setting the lamination on a table vice with the vice tightened to properly hold and compress the lamination which are arranged in such a way that they overlap equally at the edges, welder together minimize noise (hum), with associated loss effect.

The primary coil and secondary coil which are wound on the plastic form are inserted in to the lamination, which is in form of E-shaped lamination and then stacked to give a rectangular shape, the primary and secondary end coils where brought through the lead connection, the primary leads serves as the input of the transformer while the secondary lead were connected to the welding tongue.

Finally, the transformer was mounted inside the metal case called enclosure (covered), the metal case was constructed out of metal sheets the transformer is mounted inside the metal sheet to avoid vibration which may also result to humming sound.
All other accessories were linked, connected or attached and these includes the input and output leads, IC oscillator, inverter circuit, rectifiers, capacitor, resistor, diode, inductance, welding and earthing cables, electrode holder attached to the welding cable and fan for cooling the system. As well as room for ventilation purpose. The casing arrangement is shown in figure 3.

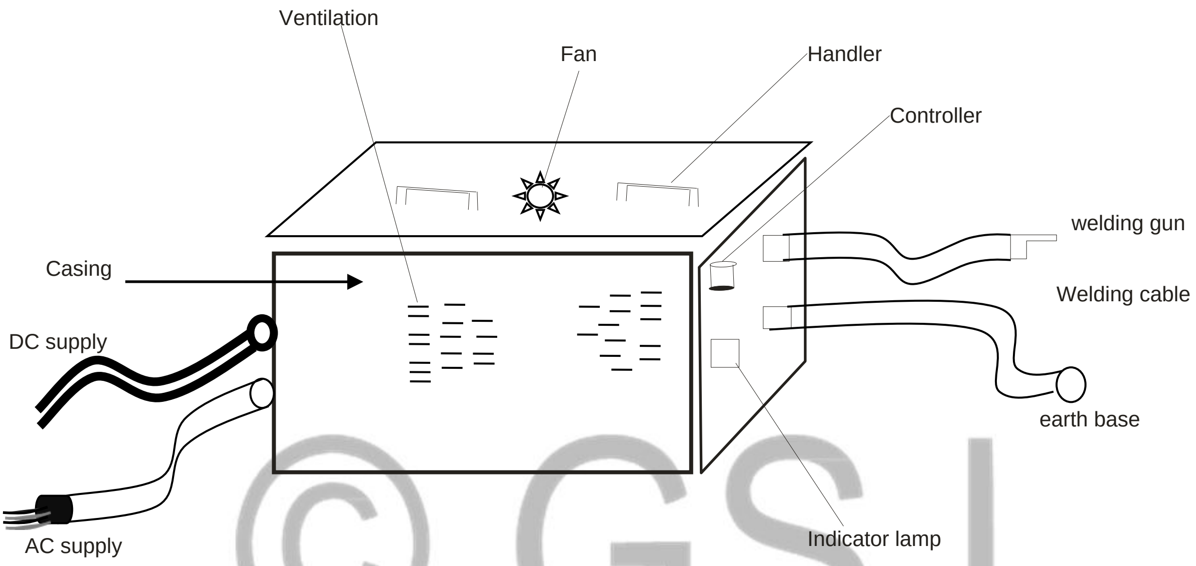

Figure 4: Casing arrangement

Principle of Operation

This paper had shown a high bridge hyb arc welding machine. The designed project is 220Votl AC power mains and 24V DC batteries main supply. The transformer TR consist of two windings, the primary and secondary parts. The primary winding is connected to an AC input supply of 220V and the secondary winding of 24V is a central tapped full wave rectifier circuit. This D_1-D_4 6A diode x 8 rectifier the output 24V to +24V DC, the +24Volt is fed to the regulator and the h-bridge inverter circuit. The regulator (7812) is provided to regulate the +24Vdc to +12V needed to power the oscillator (SG 3524). The SG 3525 is used in the oscillation section of the inverter. This IC is used to generate the 50Hz frequency required to generate AC supply by the inverter. The pin 6 and 7 of the IC are the oscillation section pins. The frequency produced by the IC depends on the value of the capacitor and resistor connected at this pins. The capacity (2104 PF) is connected to pin 7. This capacity decides the 50Hz frequency output by the IC pin 6 is the timing resistance pin. The resistance at this pin keeps the oscillator frequency constant. The R5 is a (10k) present variable resistor connected to the ground from pin 6 of the IC to adjust the output frequency. C_1 is connected in parallel with variable resistor and fixed resistor from pin 1 of the IC to ensure filtration of decoupling. R3 (10k) variable resistor is used to control the output current. The +12 output voltage from pin 13 of the IC oscillator is fed to R3 and R9 and R11 to the gate of MOSFET (IRFP064) and NPN transistor (C9014). The 24Vdc battery supply the inverter circuit with half bridge inverter to rectifier and filter. The two MOSFET (IRFP064) helps to control the pulse generated from the oscillator. The two identical capacity voltage capacity (4700) 400V C5 C6 helps to boost the current as required by the welding. An inductance connected in series with C5 is used for filtering and to ensure a free flow flux from the output of the work piece.

Table 1 Shows below is Maintenance Prescription Manual

Table 1 Maintenance Prescription Manuel

S/N	FAULTS	CAUSE(S)	REMEDIES
1	Machine does not start	No power supply Incorrect supply voltage Blown fuse	Check voltage, check power replace fuse
2	Machine delivers current but short down	Over loading power leads to tooling or too small. Ambient temperature too high. Ventilation block.	Reduce welding current Replace with large cable Operate at reduced loads
3	Machine shocks	Damage supply cable Winding bridging to core	Change supply cable. Insulate winding or replace windings. Change supply cable.
4	Electrode holder heats excessively.	Partial contact between holder and welding cable.	Insulate winding or replace windings. Ensure light contact between holder to welding cable.
5	Machine vibrates excessively.	Wrong huge of electrode.	Use proper gauge of electrode. Retighten lamination.
6	Joint will no melt properly.	Current too low. Supply voltage too low.	Increase or adjust the controller knob (regulator)
7	Welding low and spatters excessively.	Current setting too high. Incorrect electrode used.	Check setting and output with dimension.
8	Machine overheating.	Overloading wrong connection.	Stop machine immediately. Check the switch and reduce welding.

Precautions

- Ensure that the cooling fan is working
- Check the condition of the electrode holder for proper best insulation and good electrical contact with the electrode.
- Check if the welding cables are electrically continuous.
- Using the proper glass recommended for welding machine.

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4. TESTING, RESULT AND DISCUSSION

Testing

Table 2: Table of testing results

Power supply	Input voltage	Output voltage	Input current	Output current
DC Battery	24V	50V	20A	20A
AC Mains	220V	50V	35A	50A

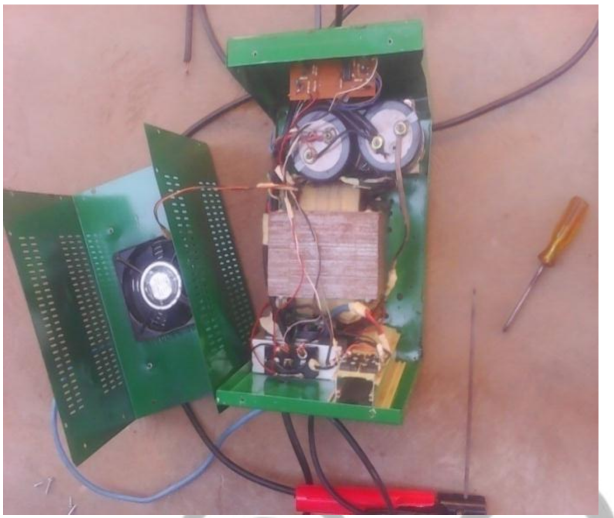


Figure 5: Pictorial diagrams

Physical specification of the machine

Height = 22mm
Length = 32mm
Width = 24mm

Result

After the construction, open circuit and short circuit test were carried out. The physical working of the machine was also carried out.

The open and short circuit tests enable us to determine the efficiency, power factor and voltage regulation of the transformer, which are 96%, 73% respectively. Table 2 shows the testing results details

Discussion

After the design and construction, open circuit and short circuit test were carried out. The physical working of the machine was also carried out.

The tongs of the electrode holder grip the electrode tight for different job position; hence no arcing effect was noticed on the tong. Arc production with the different gauge of electrode was very satisfactory for the metal works.

It has good and high operational efficiency and test shown that the design specified the anticipated requirement.

Note: If 24Vdc 200AH batteries used is fully charged, the machine will last on load at 8hours during operation.

5. CONCLUSION

Conclusion

The design and construction of an hybrid single phase arc welding machine has been successfully presented in this research.

The 24volt output from the transformer rectified to DC and regulated with (7812 regulator) to 12volt which is needed by the IC SG3524 oscillator to supply an out to the inverter circuit. The inverter helps to control the 24volt batteries to a required voltage/current needed by the welding machine. An inductance (current transformer) is connected in series with the inverter to give free flow of flux at the welding output. A 10k variable resistor is connected across the oscillator to vary the output current. The use of fan as a cooling medium enables the transformer, oscillator and semiconductor component embedded in the circuit to operate on a continuous duty cycle.

The successful completion of this research has broken the mystery behind transformer construction.

The study will be of great importance to Engineers, Technologies, Technicians, Artisans and those involved in metal work business.

Recommendations

It is here by recommended for anyone who wishes to improve on this paper, emphasis should be made on the improvement of the efficiency of this machine. This can be made by installing solar panel to charge the 24volt DC batteries to have a continuous welding process.

It is also recommended to improve on the power rating of this machine precisely the DC power outage to prolong the operating hours.

REFERENCES

Aghakhani, M., Ghaderi, M. R., Jlilian, M., & Derakshan, A. A. (2014). Combined effect of TiO2 nano-particles and welding input parameters on the hardness of melted zone in submerged arc welding by fuzzy logic *int. J. Adv. Manufacturer technology*, 70, 63-72.

Asiwe, U. M., Edem, A. and Edeafeadhe, G. (2018). Design and Construction of an Electric Arc Welding Machine's Transformer. Electrical /Electronic Engineering Department, Delta State Polytechnic, Otefe-Oghara, Nigeria. Published @International Journal of Trend in Scientific Research and Development (IJTSRD) International Open Access Journal 2(6). website@www.ijtsrd.com

Bhujbal, V. D., & Tadamalle, A. P. (2013). Optimization of laser welding process by fuzzy logic technique. *International journal of engineering science and innovative technology*, 2(4), 221-227.

Chen H. C., Pinkerton, A. J., Li, L., Liu, Z., & Mitry, A. T. (2011). Gap-free fibre laser welding of Zn-coated steel on Al alloy for light-weight automotive applications, Materials and Design, 32(495).

Frank A. (2003). Welding aluminum with inverter-based power supplies https://www.thefabricator.com/article/aluminumwelding/welding-aluminum-with-inverter-based-power-supplies

Ibrahim, I. I. Adamu, B. I. (2016) Design and Construction of a Welding Machine with a Variable Current Selector . Department of Physics, Federal University Dutse, Jigawa

State International Journal of Pure & Applied Sciences.Vol.6No.2. Published by Oxford Research and Publications

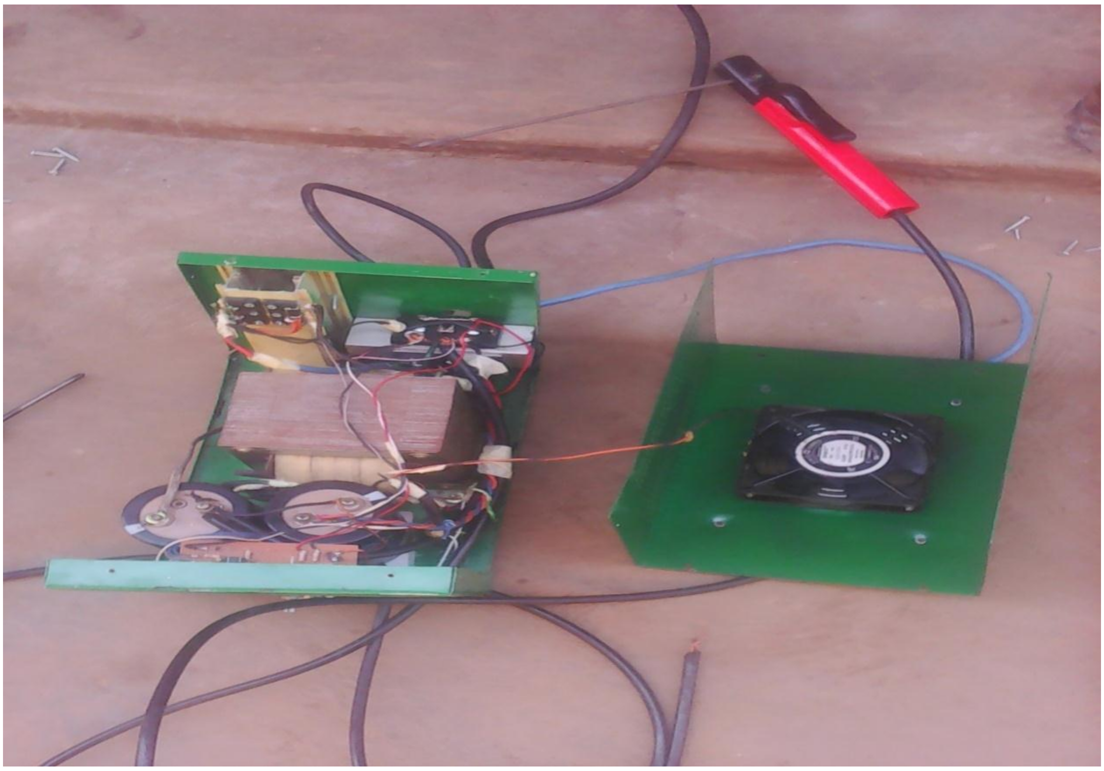
Kikani P. (2016) Welding as sustainable manufacturing process for fabrication industries https://www.researchgate.net/publication/297076951_Hybrid_welding_as_sustainable_manufacturing_process_for_fabrication_industries/citation/download

APPENDIX

Appendix A: Bill of Engineering Material and Evaluation

S/N	MATERIAL DESCRIPTION	SPECIFICATION	QUANTITY	UNIT PRICE(N)	TOTAL (N)
1	Electrode holder	600A	1	1000	1000
2	Battery cable	10mm	3yard	265	700
3	Welding cable	10mm	4yard	250	1000
4	AC main supply cable	10mm	2yard	300	600
5	Metal sheet	1.6mm sheet	½ full size	2500	2500
6	Electrode (gauge 12)		1	300	300
7	Lamination (core)		1	14800	14800
8	Bobbin	Wooden	4	100	400
9	Fuse		1	300	300
10	Round copper wire (input)	S.W.G gauge 16	4kg	2600	10400
11	Flate copper wire (output)	S.W.G gauge 11	3kg	2600	7800
12	Indicator lamp	LED	1	200	200
13	Controller knob	W.L	1	200	200
14	Paint	Medium tin	1	500	500
15	Masking tape	Abro	4	100	400
16	Cord insulator			300	300
17	Bolts	12mm	4	120	480
18	Nut and washer	8mm	14	40	560
19	Screw	5mm, 3mm	30	300	300
20	Cooling fan	015Amp 24W	1	1000	1000
21	Cable lock	10mm	2	100	200
22	IC oscillator unit	SG3524			3800
23	MOSFET	IRFP064	2	2500	5000
24	MOSFET Transistor	C9014	1	2500	2500
25	Power capacitor	4700, 400V HCG	2	4500	9000
26	Vanish		1litre	500	500
27	h-bridge rectifier	6Ax8, 6Ax5			1800
28	Logistic				6000
	TOTAL				**72,240.00**

Appendix B: Interior view of the whole project



Appendix C: Exterior view of the whole project