Design And Construction of An Electrical Arc Welding Machine

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TITLE PAGE

DESIGN AND CONSTRUCTION OF AN ELECTRICAL ARC WELDING MACHINE

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APPROVAL PAGE

se project reports has been approved for the department of elect / elect school echnical studies, federal collage of education (technical) Gombe, Gombe e

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Knowledge as then say is an exhaustible inquiry and its acquisition is a continues cess.

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so complexity is the fact of humanity.

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DEDICATION

licate this project to the alpha and omega of my life. Struggle whose wisdom and unfailing has stimulated as seed of greatness in my life, also to all members of our family more cially my father Mallam Abdullahi Hassan (wase) and my mother Malama Hafsat llahi (Asabe tele).

ABSTRACT

need to improve the development of joining two or more metal together, a lot of is has been put in place. Which resulted in the development of many devices or es to carter for this condition. In this project, the construction of electrical arc welding e for domestic purpose is been described under distinct two (2) basic sections:
Power supply as the energy source, which anergise the engine, secondly, the motor (fan) rving as cooling agent in this project to in order to cool. The engine from excessive heat ed during operation. For the smooth take up of the work. These sections perform distinct r-related functions as explained sequentially in this project content.

TABLE OF CONTENT

CHAPTER ONE

INTRODUCTION

ly in the nineteenth century Sir Humphry Davy showed that a brilliant source of light could obtained by connecting a pair of carbon rods to an e.m .f greater than 40v. This source sisted of arc or inendescent flame which was struck by bringing the ends of the rods ther and drawing them strictly apart.

ring the second half of the century considerable use was made of this form of illumination, inventors showed much ingenuity in designing mechanism to srike the arc advance the of the rods are they slowly buant away, it has metal electrodes surrounded by xenon gas.

The temperature reached in the electric arc is in the region of 3700c. This is well above melting point of metals, and therefore the main application of the arc is in electric nances and welding equipment. Two types of electric arc are used. The larger ones employ bon arcs and are used for melting special steels. The smaller arc are used in research work, e have a tungsten rod which acts as one electrode, while the metal to be melted forms the er electrode.

ELDING: - is a fusion process using electrical energy to provide the heat necessary to duce melting of the work and electrode. In welding, a metal rod is connected to one minal of the supply and the two pieces of metal to be joined are connected to other. The arc truck by touching the joint with the end of the welding rod. The heat generated melts the and the two components are fused together.

e electric arc welding machine consists of the following component which makes up the achine:-

The fuse.

1. Indicator lamp.
2. Switches.
3. Motor (fan).
4. Transformer.
5. Regulator.
6. Lead cables;
7. Electrode handle.
8. Metal case.

DESIGN REQUIRMENT

e under listed materials and components required for the purpose of this project nstruction are:-

1 Fuse.
2 Switch.
3 Indicator lamp.
4 Cooling fan (motor).
5 Transformer.
6 Regulator (terminal).
7 Lead cable.
8 Electrode holders.
9 Metal case.

IEF DESCRIPTION OF COMPONENTS AND THEIR APPLICATION

FUSES: - A fuse is defined as device for opening a circuit by means of a conductor designed to melt when an excessive current flows along it. The fuse comprises all the parts of the complete devices, Which include the following :-

Fuse element b. cartridge fuse c. fuse – link.

FUSE ELEMENT: - that part of a fuse which is designed to melt and thus open a circuit.

CARTRIDGEFUSE: - a fuse in which the fuse element is totally enclosed in a cartridge.

FUSE – LINK: - that part of a fuse which comprises a fuse element and a cartridge or other containers, if any and either is capable of being attached to fuse – contacts or is fitted with fuse – contacts as an integral part of it.

THERE ARE THREE TYPES OF FUSE

1. Rewirable fuse.
2. The cartridge fuse.
3. H.B.C Fuse (high breaking capacity)

Three terms are use in connection with fuse:-
1. current rating 2. Fusing current 3. Fusing factor

1. CURRENT RATING:- this is the maximum current that a fuse will carry indefinitely with out undue deterioration of the fuse element.
2. FUSING CURRENT: - this is maximum current that will "blow "the fuse.
3. FUSING FACTOR :- this is ration of the minimum fusing current to the current rating namely :-

$$\text{FUSING FACTOR} = \frac{\text{minimum fusing current}}{\text{Current rating}}$$

FIQURE 1.1

CARTRIDGE FUSE

2. **SWITCH'S:-** IS an Electrical Component Used for Opening and Closing Circuit under Normal and Abnormal Condition.

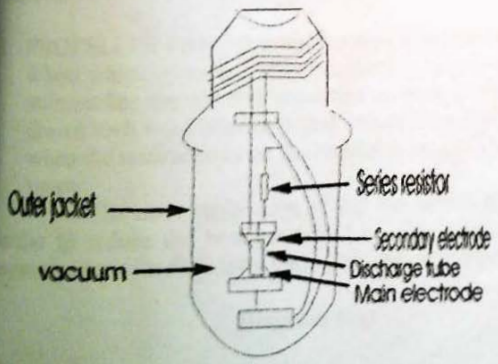
Therefore Switch is required to make a low resistance Connection in the ON Setting and Very High Resistance insulation in the OFF setting. The resistance of the switch at when the switch is ON (made) is determined by the switch contact, the moving metal parts in each part of the circuit which will touch when the switch is ON , the amount of contact resistant Depend on the area of contact, the contact material, the amount of force that presses the contact. Together, an also in the way that this force has been applied. IF the contact of scraped again each other in the wiping action as they are forced together, then the contact

sistant can often be much lower than can be achieved, when the same force is used simple push the con tact straight together.
In general, large contact area are used only for high current operation and contact are as low – current switches as used for electrical and electronic circuit.

Diagram two

INDICATOR LAMP:- this is an electrical and electronics component for converting electrical energy into illumination, further more its used to indicate weather the current is passing into the the system or not.
Mercury lamp:- as the name implies is a device that will give off visible light whenever it is energized b the power source. It has arc tubes made of quartz to with stand the temperature and pressures involved.

The mercur lamp gives most out put in the violet, green and yellow parts of the spectrum, so the basic colour rendering is not good. The light out put is often modified by adding metallic halides to the gas, or by using a fluorescent coating inside the outer bulbs.



COOLING FAN (motor):- A fan is a kind o pump which is used for blowing or ulating the air through the entire duct system and the conditioned space. It is usually ated at the inlet of the air conditioner. A fan essentially, consists of motor and rotating eels (called impeller) which are surrounded, by a stationary member known as housing. e energy is transmitted to the air by the power driven wheel and a pressure different is ated to provide flow of air. The air may be moved by either creating an above atmospheric ssure (i.e. positive pressure) or a below – atmospheric pressure (i.e. negative pressure). s produced both the conditions. The air at the inlet to the fan is below atmospheric ssure while at the exhaust or outlet of the fan is above atmospheric pressure the air feed o a fan is called "induced draft" while the air exhaust from a fan is called "forced draft".

The fan irrespective of there type of construction, may function as either blowers or austers. The blowers discharge air against a pressure at their outlet where as exhausters ove gases from a space by suction.

TYPES OF FAN

1. Centrifugal or radial flow fans
2. Axial flow fans

IAL FLOW FANS: - are divided into the following three group:-
Propeller fan 2. Tube axial fan 3. Vane axial fan

1, PROPELLER FAN:- A propeller type of axial flow fan consist of a propeller or disc type wheel which operates within a mounting ring as shown below the design of a ring surrounding the wheel is important because it prevents the air discharge from being drawn back ward into the wheel around its periphery. The propeller fans are used only when the resistance to air movement is small. They are useful for the ventilation of attic space ,

The main application of this fan in this project is to blow air to the transformer in order to reduce the heat generated by the transformer when working. And to make the system continues for a long period of time which out any breaks down.

Diagram four

TRANSFORMER: - is a static (stationary) piece of apparatus which transfer electrical ergy from one A.C circuit to another A.C circuit with a change in voltage but no change in quency. It can raise or lower voltage in the circuit but with the correspondent decrease or rease in current. The physical basic of a transformer is mutual induction between two cuit linked by a common magnetic flux.

The basic A.C power source delivers only A.C current and consists of a transformer uired to reduce the main supply voltage; usually in 220—240v to a voltage at a much safer el and more suitable for welding, the maximum value allowed in accordance with home fice regulations. In corporated in each welding set is a regulating device to control the rrent out put of the set.

The following is the diagram of a simple transformer:-

Diagram five

here are two types of transformer construction namely:-

1. Core – type.
2. Shell – type.

But our discussing on this project lay emphasis on core—type transformer construction.

E MATERIAL: - The magnetic materials of which the core is made. Since it most always is subjected to A.C magnetication, the core material and construction must be chosen to reduce iron losses to a minimum, or the transformer will not be efficient. Most transformer cores are made from "laminated silicon steel", the lamination is designed to reduce the eddy current and the silicon steel keeping hysteresis loss to minimum laminations must be tightly held by clamping or by taping. Or they are likely to vibrate and produce excessive noise, as well as increasing the air gaps at joints, some small high – frequency communications transformers have core cast of solid ferroxcub, the eddy current loss thus being kept to a reasonable level.

E ARRANGEMENT:-if a transformer were wound with primary and secondary on separate limbs of the core, a proportion of the magnetic flux produced by the primary winding will not pass through the secondary. This "leakage flux" reduces the transformer efficiency and results in poor voltage regulation and generally it must be reduced to an absolute minimum.

The arrangement is called a core type transformer, the windings being split, with part of each wound on each side of the magnetic circuit to reduce leakage flux.

CORE TYPE

DIAGRAM six

kage is reduced still further by using the shell – type circuit both winding are placed on the tre limb, the two outer limbs providing parallel return paths for the magnetic flux.

$$\text{FORMULAR} = \frac{N1}{N2} = \frac{V1}{V2} = \frac{I2}{I1}$$

LOSSES IN TRANSFORMER

ansformer is highly efficient piece of equipment; mainly because thre are moving parts are how- ever two source of losses.

1. Copper loss.
2. Iron or core loss.

1. **Copper loss: -** This loss is a heat loss due to the current flowing through the copper windings. It is termed as (I^2R) loss. It varies as the square of the current (I^2) copper loss at half full load is one fourth of that at full load.

IRON OR CORE LOSS

EDDY CURRENT LOSS: - eddy current are alternating currents which are induced into he metals core of the transformer by the alternating field in the core.

DIAGRAM SEVEN

This loss is reduced by using thin laminations. Are insulted from one another to keep the eddy current paths separated to reduce the e .m .f and to increase the resistance per path.

ii .**HYSTERESIS LOSS**: - this loss is due to the energy that being in the core during the changing cycle of magnetism. A certain amount of magnetism remove after current has collaped. This retained or residual magnetism must be neutralized and the energy used to neutralize it represents a loss. This loss is minimised by using a core in which the residual magnetism is small, silicon steel is the most common core material as it retains little magnetism and provide a low reluctance magnetic resistance to the lines of fulse.

TRANSFORMER EFFICIENCY

$$\frac{\text{Output power}}{\text{Input power}} \times 100\%$$

$$\frac{\text{Input power} - \text{losses}}{\text{Input power}} \times 100\% \qquad 100\% \ \frac{\text{Input power} - (\text{iron loss} + \text{copper})}{\text{Input power}}$$

In welding machine the output or secondary winding of the transformer is required to produce higher current and minimum voltage, the current is readily available and for this reason A.C welding transformers are the most widely used power sources in industries, work shops. They are generally the most efficient and reliable with low capital cost. A transformer may be either oil cooled or air cooled.

Oil cooled models in which the oil acts both as an insulator and coolant have no moving parts, giving low operating and maintenance cost and are silent in operating. The larger rated air cooled models use forced air circulation automatically provided by a fan – motor when the set is switch on.

Further more, in the A.C welding machine the transformer power source reduces the primary voltage and has means of regulating the current on the secondary side consequently higher in weight making them more portable. A.C power source are available as single operator, double operator, multiple operator set, depending upon the type and quantity of work to be welded, and in various capacities up to 650 ampere, this is refer to the maximum current at which the machine will operate at a particular duly – cycle. Transformer power source do not have variable voltage control. The open circuit voltage is selected by connecting the welding lead to an output terminal usually 80 or 100 volt.

6. **REGULATOR OR TERMINALS**:-In some welding machines, the secondary side or winding need to alter or varies from lower to higher depending on a size, thickness or groups of metals to be melts, this can be achieved by providing the regulator or terminals to select the suitable current for melting the pieces of metal.
In this project the transformer winding is designed with three tapping and numbered from 1, 2, to3. In which first is greater than second and second is greater than third.

TAPPING:- Are connections made to the winding which are brought out to a connection box so that the effective numbers of turns on the winding can be altered by changing connections.

DIAGRAM EIAGHT

LEAD CABLE: - One of the most important items in the circuit is the welding cable. The connections of the power source to the main supply with the primary cable, is there is esponsibility of qualified electricity.

How ever, the secondary cables is responsibility of a qualified electrician, also, the econdary cable including the welding lead from the power source to the electrode holder, the eturn current lead from the work piece to the power source and the earth lead are concern to he welding technician. The secondary cables should be flexible to permit easy manipulation f the electrode holder during welding. To produce this flexibility between 500 – 3000 fires opper wire 0.2mm diameter is used in each cable. The wires are well insulated with rubber hich must be durable and resistant to any hazard that may occur. The size of the cable used epends upon the maximum current output of the power source and the length of the cable ed

The longer the length of the cable in the welding circuit, the grater will be the resistant to he flow of current resulting in a voltage drops reducing the power available at the electrode. f the total length of the welding cable is in excess of 15m it may be necessary to use cable of larger cross – section to ensure that the voltage drop is not excessive

DIAGRAM NINE

ELECTRODE HOLDER (HANDLE):- An electrode holder is used both to hold the lectrode to provide a safe insulted handled for the welder. It carries the currents from the elding lead to the electrode, the welding lead usually being fastened to the electrode holder nside the handle. Clamping portion holding the electrode should ideally have copper jaws for good electrical contact with grooves cut into the jaws, enabling the electrode to be held at

Varying angles for positional work. A completely insulted electrode holder should always be used and is considered essentially when working on site, out doors in confined spaces or where the need for safely is of the utmost important.

Electrode holders are available in sizes to match the maximum current output of the power source

a. Twist grip type in which turning the handle operated a screw mechanism developing a pressure grip on the electrode.
b. In which a coil spring is used to provide the pressure to hold the electrode

Diagram TEN

3. **METAL CASE (ENGINE CASE):-** Metal case or box is a housing casement of the project to accommodate the circuit.

The housing can be obtained by the folding the metal to the required shape of the box which can be rectangular or square in shape as the case may be

The thickness of the metal sheet should be 1 – 0.2 standard wire gauge (S.W.G). Eventually the metal case will be decorated by finishing material e.g. paint.

CHAPTER TWO

2. O DESIGN PROCEDURE

This chapter consists of the two stages which analyse the design procedure of this project work.

The stages are as follows:-

1. Cooling or (motor) stage.
2. Power stage.

COOLNG OR (MOTOR) STAGE:-To construct an electric arc welding machine there's need to provide cooling system in order to keep the machine running for a long period of time, and among all is it increase the life span of this engine.

The A.C motor used in this project is the single phase motor to perform the work, how ever, since majority of equipment are provided with single phase – supplied. This type of motor is commonly used in domestic welding machine, refrigerators, vacuum cleaners, food mixer and other appliances.

Single – phase A.C motor may be divided into the following classes namely:-
1. Split – phase 2. Repulsion type 3. Shaded pole and 4. Universal series motor

1. Split – phase provided a means of starting single – phase motors by using two winding to create a phase difference between the main winding and the starting winding so as to produce a rotating magnetic field. This split – phase induction is one of the most popular of the fractional horse power motors. It consist of:- 1. Squirrel cage motor 2. Two winding in the stator 3. Centrifugal switch the two winding in the stator are connected across the single phase A.C source, the currents in the two windings lags the applied voltage by 90 electrical degrees.

DIAGRAM ELEVEN

The mains or running winding has low resistance and high inductance while the auxiliary or starting winding has high resistance, and low inductance. When current flows through the two winding a phase difference is created which produce a rotating magnetic field.

This field induced an E.M.F. into the squirrel cage – rotor to produce another magnetic field. The interaction of the two fields will force the rotor to start similar to the 3 – phase induction motor.

POWER STAGE: - In electric arc welding machine the power unit consist of the transformer which is the "back bone" of the engine.

The transformer is an electric device which transforms electrical energy from one A.C. circuit to another A.C. circuit with change voltage as well current. With out change in frequency.

The transformer consists of coil(s) and laminated self iron core or ferrite core (i.e. to increase the magnetic field stren th and hence the induction effect).

The transformer used in this project consist both of step up and step down transformer.

1. **STEP UP TRANSFORMER**:- This is when secondary turns are more than primary turns than it increase voltage and reduce current.

This transformer is the step up in terms of voltage because the primary voltage is 240v. While the secondary voltage varies into three tapping, the first is higher than the second and the third is the lowest in order to suit the requirement.

The principle of operation: - the first transformer as stated above is core – type, single phase step down in term of voltage and step up in term of current. Which posses two winding transformer. When one coil / winding (primary) is connected to an alternative voltage or pulsating D.C. an alternative flux is step up in the laminated core.

This flux go round through the core and cut the secondary coil. Induce E.M.F. T. that set current into motion. Since the number of turn in the primary coil is more than that of secondary.

As shown in the diagram below:-

DIAGRAM TWEELEVE

CHAPTER THREE

3. O ConStruction DETAILS

This chapter describes the method and process of construction, the problems and solution devised during the construction. To simplify the chapter it's divided into three and sub divided into six.

1. Motor unit.
2. Transformer unit.
3. Casement (engine case).

MOTOR (FAN) UNIT: - Been the engine as the device which liable to generate heat at rtain time, the need of coolant is necessary in order to give the free flow of the operation. his project, I have positioned the motor (fan) in such a way that the engine takes a long time l out over heating. During construction I take an agreement to employed the refrigerator or (fan) to serve as a cooling agent in the circuit.
motor is attached to three plate of propeller for air blower.
connection is directed from the supply. The more the engine is switched on, the speedy the rotation.

TRANSFORMER:- Is divided in to four subdivision part namely:-

I. Lamination.
II. Insulators.
III. Copper wire in primary winding.
IV. Copper wire in secondary winding

I. Lamination:- with the magnetic materials of which the core of made since it most always the be subjected to A.C. magnetization, the core material and construction must be choosing to reduce iron losses to a minimum, or the transformer will not be efficient.

In this project, the transformer cores are made of silicon steel, the laminations ucing edely currents and the silicon steel keeping hysteresis lows to a minimum.

The lamination is arrange so as to produce the air gabs in the magnetic circuit and is tightly held by clamp. The size of the lamination is 120 / 180mm respectively, and I divided it in to (34) pieces for primary and secondary core.

Below is the diagram of the lamination size:-

Diagram THREEN

The choosen of these types of lamination is as a result of higher conductivity and lower resistivity.

ii. **INSULATORS:** - To construct the transformer core, with conductive material like metals and need of insulation is compulsory in other to separate the core from the copper wires.

The lamination is insulated by the special insulator "Insulated ladder" to serve as insulator in order to avoid short circuit by toughing the core which course the engine to generate heat.

Below is the example of the insulation place:-

Diagram FOURTEEN

iii. **COPPER WIRE AT PRIMARY**: - The copper wire at the primary winding is two quantity and the gauge is (12) the number of turns or winding is 200 turns wound in the primary core. While in put voltage is 240 / 200v.

iv. **COPPER WIRE AT SECONDARY**: - In the secondary side of this transformer the wire is 1.05 quantities and is gauge eight (8). The number of turns is varied in to three groups or tapping first is 120 turns higher, 50 turns medium and 30 turns serve as the lower. In the secondary core.

3. **CASEMENT (ENGINE CASE)**:- After observing the quality of metal to be used as cover (house). I have realized to used the silicon steel because of its higher resistivity to heat, temperature and sunlight. And is constructed in such a way that it protect the circuit from external faults and beautify the project too.

The colour of the pain is green, while the thickness of the sheet metal is 0.8mm that's (24) standard wire gauge (S.W.G.).

Diagram is below:-

DIAGRAM FIVETEEN

PUT PUT ACCESSORIES:- At the input of this electrical arc welding machine, I provided the wires socket to provide the power supply that feed the engine fro,\m the socket out let of the main supply

However, at the output there are two cables one to serve as lead (positive) and the other lead (negative). The positive lead cable is attached to the electrode holder, while the negative lead cable is attached to the work piece.

PROBLEMS ENCOUNTER AND SOLUTION DEVISED

As the matter of fact there are problems encounters during the construction of this project these are:-

1. In availability of obtained the exact gauge required at the right time
2. In adequate and experience on how to coil the copper wire in both primary and secondary side

TO SOLVE THE ABOVE PROBLEMS:-

1ST problem was solved by reducing and adding the size of the gauge to meet the exact number required.

2nd problem was solved by regular practice and learning from the wizard before comforting the real project.

These are the major amendment carried out at the stage of construction.

CHAPTER FOUR

EVALUATION

valuation carried out in this project involve under listed evaluation test:-

i. Eval ation before construction

ii. Evaluation after construction and encasement of the project.

e evaluation carried out in this project is purposely to determine the durability, ptability, reliability and functionality of the whole project or system.

EVALUATION BEFORE CONSTRUCTION

fore mounting of the component that the (switch, fuse, indicator lamp, motor (fan), copper re, and electrode holder). E. t. c. testing and measuring were used, using avo – meter, volt ter, ammeter, and multi meter, tester. Were used to determine the reliability of such mponent or their state of being in good condition, although this project main concentrate on C.component.

SWITCH: - A switch is tested using multimeter, the meter lead connected to each of the witch leg.

OBSERVATION MADE: - Reading was obtained so as to indicate that this switch is in good condition.

FUSE: - The fuse is also tested by using multimeter by varying the lead to the end terminals the fuse.

OBSERVATION MADE: - The fuse is realising that is in capable to with stand the required nd apply to it.

INDICATOR LAMP: - The indicator lamp is also tested using vole meter to determine its nctionality.

OBSERVATION MADE: - it is clearly indicated that the lamp is in good condition and apable to obtain the load apply to it.

MOTOR (FAN):- Is tested by using the multimeter which connect the load to the terminal of he fan also the fan is tested by connection it to direct supply A.C.

OBSERVATION MADE: - The meter deflects to show that the motor is functioning and connected to the A.C. supply the fan was rotated to its maximum speed.

OPPER WIRE: - Are tested and found are in good condition to perform the job.

LECTRODE HOLDER: - Is tested sequentially using the appropriated testing device.
OBSERVATION MADE: - The electrode holder was capable of holding the electrode perform a long job without any harmful.

CHAPTER FIVE

CONCLUTION

eral comments on the result of evaluation.

WER SUPPLY UNIT: - The oscilloscope is measuring the voltage across the load (circuit). voltage is the highest at the input while lower at the output. However, the ammeter is uring the current across both primary and secondary side in which the current is low while at the secondary.

LIMITATION

project or electrical arc welding can be operated sequentially with 240 /220v. Using of this ge above this rating will cause damage or harmful to the machine, and anything below the ated voltage will affect the effectiveness and efficiency of this machine, which probably e it not to function.

RECOMMENDATIONS

successful completion, the ~~work~~ college should equipped the workshop with all the essary tools, materials and instruments and more electrical and electronics testing device.

Furthermore, electronic and electrical (power) the collage authority should encourage and phasize fully on practical aspect during the course programme, so as to give the students out look and broaden their horizon on practical (industrially) and process of production in various pipline. I also call on collage H.O.D's to always make sure that project of good to be ibited ~~for~~ approval should be as earlier as possible to give enough time for the student to ibit a recommended project in the collage.

I then call on students to always be out to their field of study or specialization during r SIWES exercise and to always dedicate to work on project in technical education so that y should acquired the necessary skills.

Finally, I am appealing to the management to allow the student to under go difference ...tion in order to justify the student learning skill. Because there is saying "seen is ...ving".

DISAPPOINTMENTAND ENCOURAGEMENT

...of all, during the construction of this project, I experience a lot of difficulties and ...ppointment because I never wind the coil for the first time, this make me suffer a lot and ...at least more than one week to construct a transformer , but by practice, I became wizard ...is field. So in the actual sense it caused a little delay during construction.

During this project I be came a student of more interest in electronic and electrical ...eering, more over, a lot of interest is given to me by my respectable project supervisor ...m Haruna Babaji.

Finally, I am encouraging the fellow student on how to go in to this project, to start as ...as possible so as to beat the time. And to be more dedicated and sensible to their duties.

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3. **ROBERT, BOYLESTER:** - Electronic Devices and Circuit Theory.

4. Hand Out On Machine Power

BY DR. AHMAD MU 'AZU.

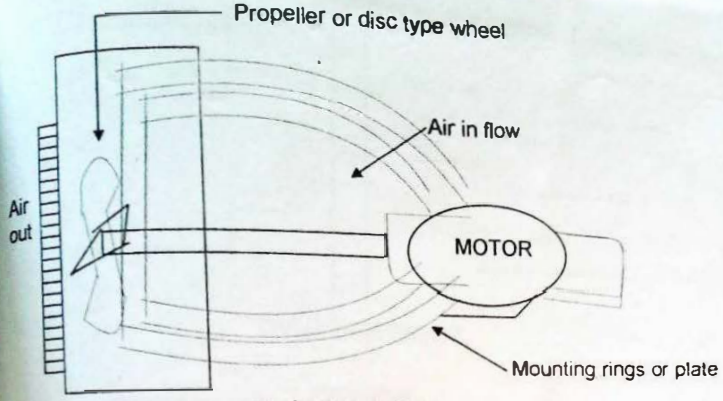
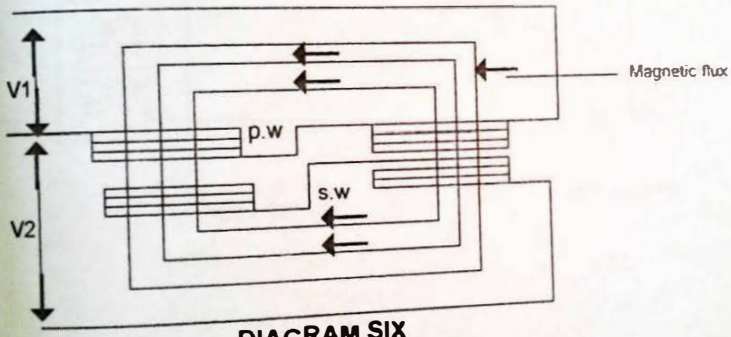


DIAGRAM FOUR



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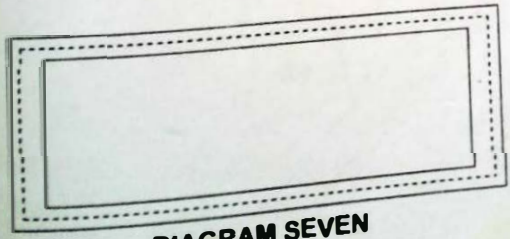

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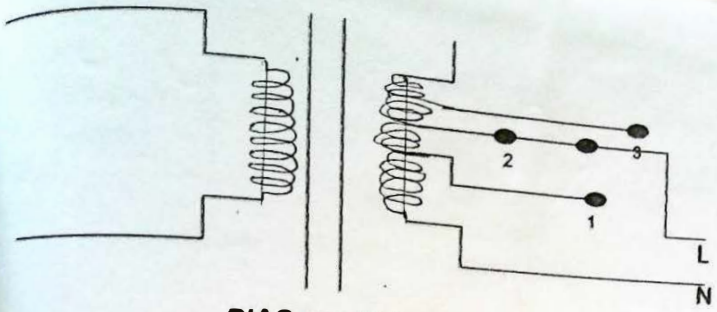

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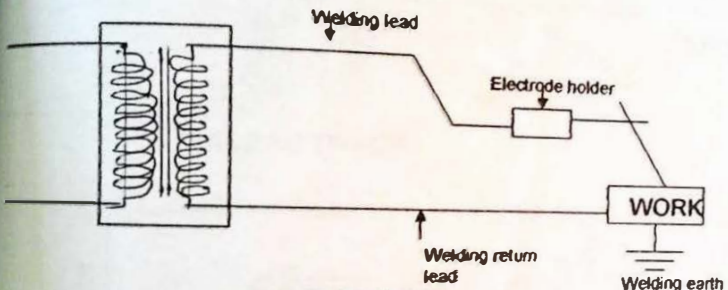

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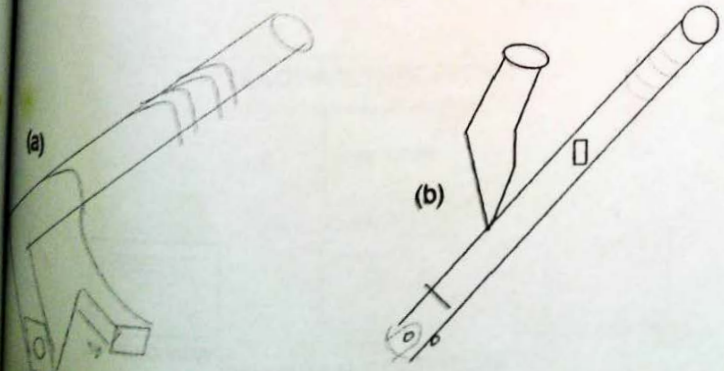

DIAGRAM TEN
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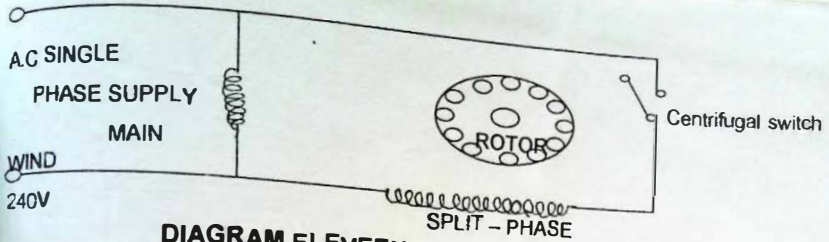

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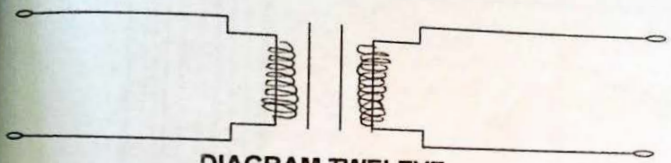

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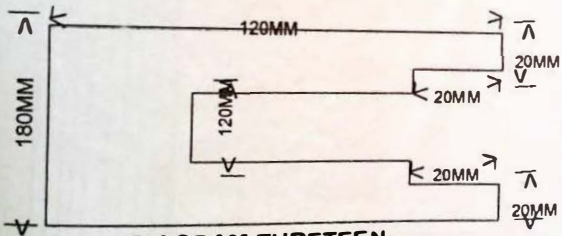

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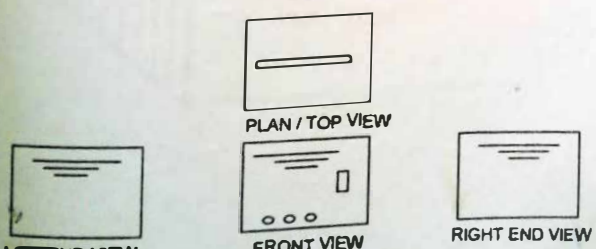

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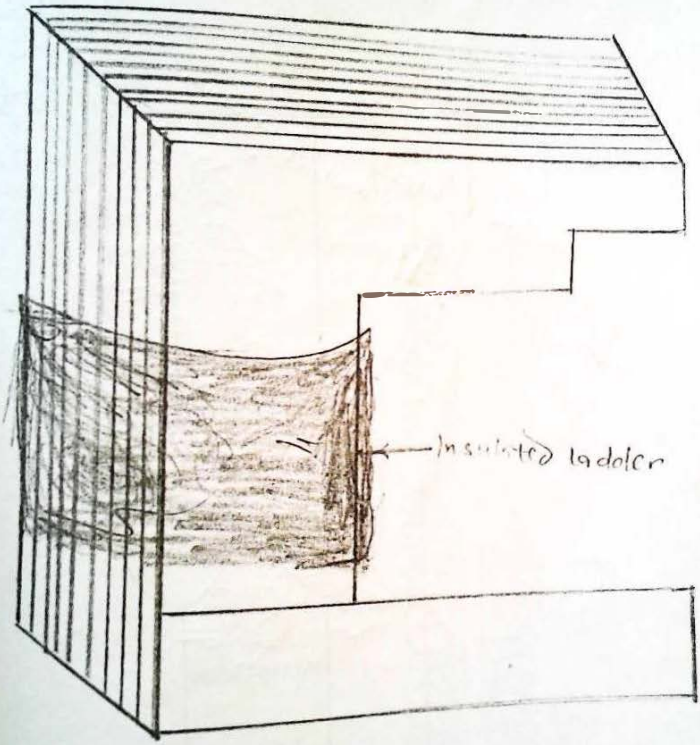

AN ELECTRICAL ARC WELDING MACHINE DIAGRAM