INTRENSHIP REPORT

ON

FUNDAMENTAL OF BATTERY MANUFACTURING AT RBL

BY

ABU AL SIRAZI

HOSSAIN AL MAMUN

MOHAMMAD RIADHUL ISLAM

Submitted

To the

Department of Electrical and Electronics Engineering

Faculty of Science and Engineering

East West University

In partial fulfillment of the requirements for the degree of Bachelor of Science in Electrical and Electronics Engineering

(B.Sc. in EEE)

Summer, 2009

Approved By

Academic Advisors

01.02.2010

Dr.Khairul Alam

Sharmin R. Ara 01.02.2010

01.02.2010

Department Chairperson

Dr. Anisul Haque

RAHIMAFROOZ

ISO 14001 Certified ISO 9001:2000 Certified

RAHIMAFROOZ BATTERIES LIMITED

705, West Nakhalpara, Tejgaon
Dhaka -1215, Bangladesh
Tel : (88-02) 9113696
Fax : (88-02) 8115305
Email : info@rahimafrooz.com

Approval Letter

To whom it Concern

This is to certify that Abu Al Sirazi, Hossain Al Mamun and Mohammad Riadhul Islam having ID-2005-3-80-004, 2005-2-80-009 & 2005-1-86-019 respectively have successfully completed the project work that was assigned to them as part of the internship program. I, Syed Abu Sadath Mohammad Munir, on behalf of **Rahimafrooz Battteries Ltd.(RBL)** am recommending this work as the fulfillment for the requirement of EEE 499 Industrial Training.

I wish their success.

14.09.09

Syed Abu Sadath Mohammad Munir
Manager, Maintenance
Rahimafrooz Batteries Ltd.

RAHIMAFROOZ BATTERIES LTD. RBL-UNIT-2

Acknowledgment

First of all, we wise to convey my heartfelt thanks and gratitude to almighty Allah to complete the Internship successfully and also those who all rendered their cooperation in making this report. Without their assistance we could not have completed our Internship.

We thank and express our gratitude to Mr. Syed Abu Sadath Mohammad Munir (SSM), Manager, Department of maintenance, Rahimafrooz Batteries LTD (RBL). We have worked under his supervision. He has guided us with a lot of effort and time.

We would like to thank to Mr. Mohammad Ziaun Nasir, General Manager, HR & QMS, Rahimafrooz Batteries LTD (RBL) for giving us opportunity to do Internship at Rahimafrooz Batteries LTD (RBL). We would also like to Mr. Khairul Alam, Assistant Professor, Department of Electrical and Electronic Engineering (EEE) East West University for his generous assistance.

Thanks also to Mrs. Sharmin R. Ara and Mr. Emamul Ahsan, Senior Lecturer, Department of Electrical and Electronic Engineering (EEE) East West University for their superb and endless help.

We also would like to thank to all the respected officers and employees of RBL, for their continuous inspiration and support.

We are also very grateful to all of our teachers and fellow friends for their encouragement and cooperation throughout our Internship and academic life.

Finally, we are forever grateful to our parents for their patience and love.

Executive Summary

This report is to introduce the fundamental of battery manufacturing. This report actually focuses on different machines, which are being used in battery manufacturing industry. The operations of these machines are illustrated here. The major technical part is the input electrical arrangement of these machines. The electrical arrangement for plate and battery charging is also focused in this report. We have discussed the details of how plates are assembled in a battery container and overview of gas engine generator has also been included in this report.

We have explored some electro-mechanical machines namely 'grid casting machine', 'oxide mill' etc.These machines use electric power as input power which is converted into mechanical power. We have emphasized on the electrical part of these machines. We have also explored some other machines and equipments that are being used in Lead-Acid battery making.

While working with Rahimafrooz Batteries Ltd (RBL), we have got a lot of opportunities to see and learn how the machines are functioning mechanically with electric power. We have tried our best to share this knowledge that has been included in this report. We would consider our effort to be successful if it has been of use to anyone.

Table of Contents

Contents

List of Figures

List of Tables

01 INTRODUCTION

1.1.1 Company profile:

Rahimafrooz operates in three broad segments – automotive after market, power and energy, and retail. While the company activities are coordinated from the Rahimafrooz Corporate Office (RACO), it has eight Strategic Business Units (SBUs), three other business ventures, and a not-for-profit social enterprise. It has strengthened the market leadership at home and abroad ranging from automotive after market products, energy and power solutions, to a world class retail chain. The team at Rahimafrooz is committed for ensuring best in quality standards and the group's four core values such as integrity, excellence, customer delight and innovation. The company's businesses initiatives are organized through their Strategic Business Units are listed below:

- Rahimafrooz (Bangladesh) Ltd. (Group Parent Company)
- Rahimafrooz (Batteries) Ltd.
- Rahimafrooz Distribution Ltd.
- Rahimafrooz Energy Services Ltd
- Rahimafrooz Superstores Ltd.
- Rahimafrooz CNG Ltd.
- Rahimafrooz Accumulator Ltd.
- Rahimafrooz Globatt Ltd.
- Rahimafrooz Renewable Energy Ltd.
- Excel Resources Ltd.

Other initiatives are:

- Metronet Bangladesh Ltd. (fiber optical network)
- Greyfab and Asiatex
- Rural Services Foundation (social development enterprise)

The company has been a leading partner in the development journey of this country for more than fifty years. The Rahimafrooz as an organization is committed to play a leading role in driving growth, prosperity, ethical values and social responsibility. Rahimafrooz Group is supposed to continue serving its customers through unparallel quality excellence and service superiority. Its business success will be complemented by their sincere commitment to the environment, society and community.

1.1.2 History of the company:

The Rahimafrooz journey dates back to the early fifties when Late Mr. A C Abdur Rahim founded a small trading company and paved the way for making of one of today's leading Bangladeshi business conglomerates. Over the decades, Rahimafrooz has grown in size, scale, and diversity. The Group today has seven Operating Companies, three other business ventures, and a non-profit social enterprise. As of 2007, the Group currently employs more than two thousand people directly and a further twenty thousand indirectly as suppliers, contractors, dealers and retailers. The major milestones in Rahimafrooz history can be summarized as below:

- Incorporated in 1954 by Mr. A.C. Abdur Rahim
- Distributorship of Lucas Battery in 1959
- Exclusive distributorship of Dunlop tyre in 1978
- Acquisition of Bangladesh operations of Lucas UK in 1980
- First producer of industrial battery in 1985
- Pioneering Solar Power in collaboration with BP in 1985
- First ever battery export – to Singapore – in 1992
- Launched Rahimafrooz Instant Power System in 1993
- Acquisition of Yuasa Batteries (Bangladesh) Ltd. – in 1994
- Attained ISO 9002 certification for RBL operations in 1997
- First India office opened in Ahmedabad – in 2000
- Awarded "Bangladesh Enterprise of the Year" in 2001
- Attained ISO 14001:1996 for RBL operations
- Launched "Agora" – the first ever retail chain in 2001
- Launched Rahimafrooz Energy Service in 2002 – promoting distributed power.
- Established Rahimafrooz CNG ltd. in 2003
- Awarded "National Export Trophy" in 2003
- Metronet Bangladesh, a fiber optic based digital solution provider communication, launched in joint venture with Flora Telecom – in 2004

- Received McGraw-Hill Platt Global Energy Award for Renewable for data Energy in 2004
- Received the "Ashden Award" for Sustainable Energy in 2006
- The Group celebrated its 50th anniversary on April 15, 2004 with a renewed, enhanced commitment to being successful while upholding its core values.
- Established Rahimafrooz Globatt Limited and Rahimafrooz Accumulator limited in 2009.

1.1.3 Founder of the company:

Late A C Abdur Rahim (1915 – 1982)

A man of strict religious values, yet a believer in progressive dynamism, and a dreamer who thought nothing is impossible – Late A C Abdur Rahim overcame numerous challenges and obstacles to become one of the most accomplished entrepreneurs of this country. Born on the 20th of January 1915, he lost both his parents by the time he was a mere seven-year old boy. Deprived of formal schooling and a typically comfortable childhood, he grew up as a man with strong determination, hardworking diligence, and humane compassion.

Mr. A C Abdur Rahim's first initiation with business was with his uncle Mr. A C Mohammad in the latter's trading business in Kolkata. By the early 1940s, Mr. Rahim started small scale commercial trading on his own. He moved to Chittagong in 1947 and started afresh with very little capital in hand, but with a whole world of courage and faith. In 1950, he established the small trading concern dealing in various items. This proprietary business was formally incorporated on April 15, 1954 as Rahimafrooz & Co. Till date; Rahimafrooz Group commemorates this as its "Foundation Day".

Today's Rahimafrooz is a dream that Mr. A C Abdur Rahim turned into reality. The business growth, the social commitment, and the great diversity are the outcome of one lifetime hard work and compassion from Mr. Rahim. He breathed his last on March 14, 1982 in London. But his work and his virtue have kept him alive forever. Allah may brace him with eternal peace.

1.2 RAHIMAFROOZ BATTERIES LTD (RBL):

Figure 1.2.a: Main entrance at Saver Plant

Rahimafrooz Batteries Ltd. is the largest lead-acid battery manufacturer in Bangladesh. The Company, with its market leadership at home and export endeavors to more than 30 countries, is among the leading regional players. RBL manufactures around 300 different types of automotive, VRLA, and customized industrial batteries. The Company's operations are certified in both **ISO 9001** and **ISO 14001** standards. Moreover to ensure occupational health and safety of the employees, company is now implementing occupational **health and safety management system** in line with **OSHAS 18001** standard.

Figure 1.2.b: Trademarks of all batteries

The Company's manufacturing plants produce a range of products – automotive, motorcycle, and appliance batteries, Industrial (stationary, deep cycle, traction, VRLA) batteries, IPS and UPS batteries, and rectifiers. Lucas and Spark are the leading names in the local automotive battery market while Volta, Optus and Delta are gaining equity as International brands.

1.2.1 Plant capacity:

Rahimafrooz has state- of- the -art manufacturing plants. It is equipped with all latest technologies with complete air treatment and lead-recycling management. RBL produces different types of batteries to meet the local and international market. Its capacity in Automotive Battery is 660,000 (N50) units per annum and Industrial Battery is 41 million AH per annum. By the end of 2010, these will increase to 8000,000 (N50) and 120 Million AH respectively. All the products are manufactured following strict quality and environmental standards. The qualities are also ensured by international certifications. Their main product range includes:

- Automotive battery
- Industrial batteries
- Motorcycle battery
- Appliance battery
- Deep cycle – Flat plate battery
- VRLA battery
- IPS and UPS batteries

1.2.2 Basics on automotive battery:

This section includes a very brief description of working principle, charging procedure, maintenance and safety precautions of the automotive battery.

1.2.2.1 How an automotive battery works

When we place the key in our car's ignition and turn the ignition switch to "ON", a signal is sent to the car's battery. Upon receiving this signal, the car battery releases energy as electrical form that it has been storing in chemical form. This electrical power is used to crank the engine. The battery also releases energy to power the car's light and other accessories.

1.2.2.2 Safety precautions when handling a battery

Handling or working with a lead-acid battery, vehicle and battery owner's manual should be consulted for instruction and safety precautions. Lead-acid battery contains hydrogen-oxygen gases that can be explosive and sulfuric acid that can cause severe burn injury. To help avoiding such risk and injury, these precautions should be followed when handling or working with a lead-acid battery.

- Safety glasses or goggles and a face shield should be worn.
- Proper clothing to protect face, hands and body should be worn.
- Work area should be well ventilated.
- Never lean on battery while boosting, testing or charging.
- Cigarettes, flames or sparks could cause a battery to explode.
- Without proper instructions and training, the battery should not be charged
- In the event of accident, the injured part should be flushed with water and a physician should be called immediately.

1.2.2.3 Maintenance of battery:

Regular maintenance of battery will ensure long life. The battery maintenance instructions can be followed in this regard. These are simple and easy instructions to follow.

- The battery should be tested on a regular basis. Battery should be also tested before driving for any long trips or before/after car has been serviced.
- Vehicle should be maintained as directed in owner's manual and/or by mechanic. This will reduce the chance of other engine components draining power from your battery. It's not always a battery's fault when your car does not start, but often a symptom of other problems.
- Regularly the battery container and terminals should be cleaned..
- Baking soda is applied to any corrosion and cover is rinsed.
- Battery's electrolyte level should be checked before charging. It should always be within the upper and lower limit mark.

1.2.2.4 How to charge a battery:

Preferably before charging a battery, car manual and battery charger manual should be consulted for instructions.

- Use a calibrated battery charger appropriate for your battery capacity & size.
- Set the battery charger at 10% of the battery's total amp hour capacity.
- In case of multiple batteries charging at a time, charge same type of battery having same amp hour capacity at the same time.
- Do not over charge or under charge a battery. An automatic battery charger with a timer that turns off after charging is the best fit.

1.2.3 Some definitions:

Active material: Chemically active compounds in a cell or battery that convert from one composition to another while producing current (electrical energy) or accepting current from an external circuit.

Battery polarity: A battery has two poles or posts. The positive battery post is usually marked as POS, P, or + and is larger than the negative post which is usually marked as NEG, N, or -. The polarity of the charger and battery must match to avoid damage to the battery and charger.

Cells: The basic electrochemical current producing unit in a battery consisting of a set of positive plates, negative plates, electrolyte, separator and casing. There are six cells in a 12-volt lead-acid battery.

Container: The polypropylene or hard rubber case that holds plates, electrolyte and separators.

Electrolyte: A solution of sulfuric acid and water that conducts current through the movement of ions (charged particles in the electrolyte solution) between positive and negative plates. It supplies sulfate ions for reaction with the active material of both positive and negative plates

Plates: Flat, typically rectangular components that contain the active material and a mechanical support structure called a grid, which also has an electrical function, carrying electrons to and from active material. Plates are either positive or negative, depending on the active material that it holds

1.2.4 Construction:

Positive Plates: The positive plates are of gauze form, built up from antimonial lead held in a vertical frames at the top and at the bas by a molded plastic bar.

Negative Plates: The lead-antimony negative plates are of pasted construction, designed to match the long life of the powerful positive plates.

Separator: Micro porous corrugated separators are used for electrical separation between plates. They are highly acid resistant, low internal electrical resistance, free from organic elements and maintain the required property throughout the life of the battery.

Container: Mould in polypropylene (PP) and Styrene Acryloniutricte (SAN) containers are strong and durable, designed to withstand all normal impact of abrasions overlong working life.

Exhauster plug: The dome-shaped microporous ceramic exhauster filter generates gas and lets it liberated out of the cells while it traps the acid spray and return to the cells.

1.3.1 Objective of the internship:

- To present the overview of Rahimafrooz Battery Ltd.
- To describe some equipments widely used in the making of Lead Acid Battery.
- To apprise the complete overview of Lead-Acid battery making process.
- To present some electrical equipment such as 3-phase motor, Rectifier, Gas generator, etc.

1.3.2 Scope:

This report actually provides a complete overview of Lead-Acid battery making Process. It also contains description of some electrical equipments being used in battery making.

1.3.3 Methodology:

This report has been written on the basis of information collected from primary sources as well as secondary sources. The primary information has been collected from personal observation, discussion with mentor and technicians. The secondary information has been taken from the company's website and manuals.

02 DETAILS OF INTERNSHIP WORK

First we have observed the operation of the grid-casting machine and studied the electrical arrangement of the grid-casting machine. The lead plates are produced from the raw material lead using grid casting machine.

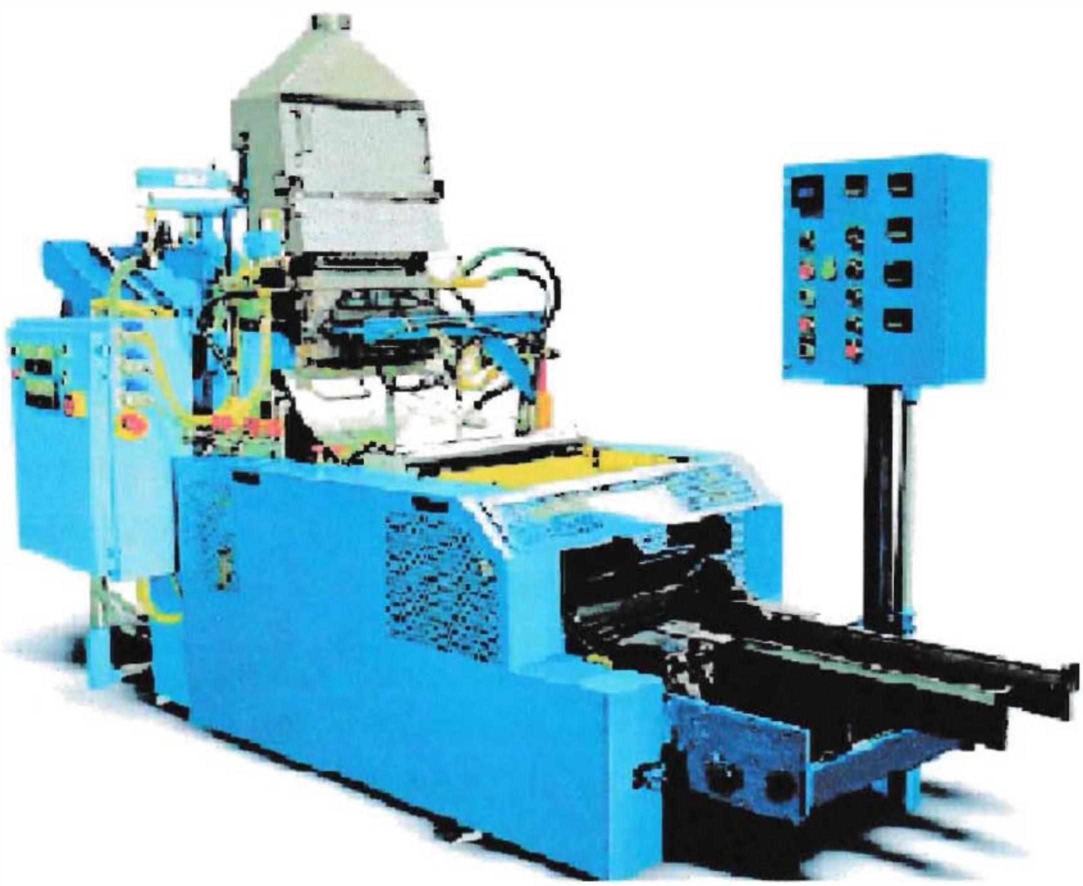


Figure 2: A picture of a grid-casting machine [WIRTZ]

2.1 Working procedure of grid casting machine:

At first antimonial lead is kept into the lead pot where heater generates 455 -480 degrees temperature to melt the lead down. Then the melted lead is transferred to the ladle through a feed line where 3 electrical heaters are used to maintain certain temperature. The flow of the melted lead is controlled by the dispense valve. The temperature of the ladle is also kept between 510-540 degrees using heater and burner. Then the melted lead is poured from the ladle to the mold. Upper mold temperature is kept at 140-170 degree where the lower mold temperature is kept at

150-180 degree. After formation of the grid, it is transferred to the transfer belt, transfer ruler, cutter and stacker eventually.

2.2 Description of some parts of grid casting machine:

A very brief description of some important parts of grid casting is given bellow:

Lead pot: Lead pot is used to melt the lead where certain temperature is needed to melt the lead down. So here 455-480 degrees temperature is needed which is generated by gas burner or electric heater. Here a lead pump is used to transfer the liquid lead to the feed line, dispense valve and the ladle.

Feed line: It is a cylindrical shaped supply line used to transfer the melted lead to the dispense valve. Here three electrical heaters are used to keep certain temperature to prevent the liquid lead from being solid. Three electric heaters are [4000watt, 3000watt, 1500watt] used to heat the feed line.

Lead dispense valve: It is used to ensure the accurate dispense of melted lead from feed line to ladle. Adjusting the timer settings can vary the amount of the dispensed lead. Lead dispense valve can be two types namely Pin type and Ball type.

Ladle part: Ladle pours certain amount of melted ladle to the mold. The movement for pouring lead is controlled by the cam and connecting rod assembly. In ladle there are burner [gas] and a heater to maintain certain temperature which is monitored on a displa y board.

Mold part: The main function of the mold is to form a solid grid from melted lead. This part has two parts namely fixed part and the movable part. Both parts have individually two heaters to maintain the even temperature in the mold. There is air inside where the grid is formed and this air has to be going out through the vent bar. The movement of the mold is controlled by the limit switch, solenoid valve and cylinder. There are some knockout pins in fixed mold to detach the grid right after the solidification. There is water-cooling system in the fixed mold part to maintain certain temperature.

Grid transport: The real eased grid from the mold has to be conveyed to the transfer rulers through a transfer belt. Then the grid is transferred to the cutter to cut the unexpected part of the grid. The scrap part is conveyed to the lead pot again through a scrap conveyer belt.

2.3 Electrical to mechanical power conversion:

The grid casting machine uses electrical power as its input power which is convertted into mechanical power.The machine uses a three phase motor which actually gives the mechanical power.This machine has two motors namely main motor and lead pupm motor.These motors need switchgear protection to prevent the damages.The bloock diagram of power convertion and switchgear protection is shown below:

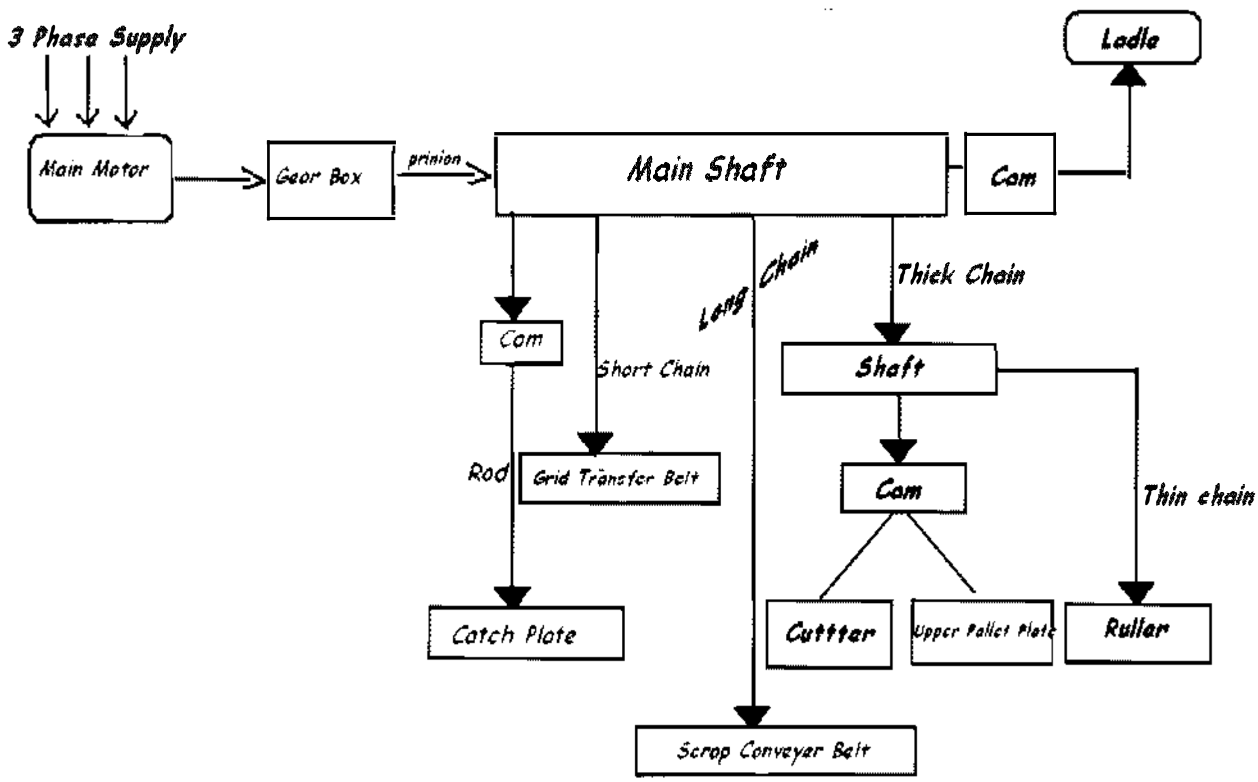


Figure2.3.a: Block diagram of electrical to mechanical power conversion

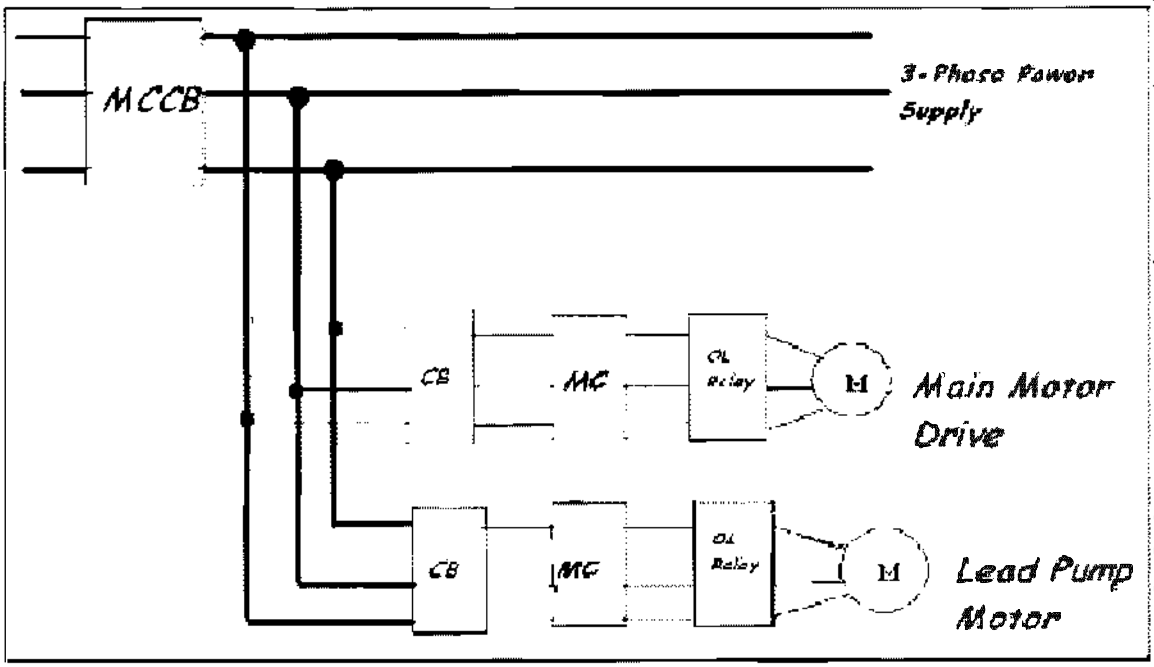


Figure 2.3.b Switchgear protection of 3 phase motors in grid casting machine

2.4 Oxide mill and its working principle:

Oxide mill produces the lead oxide from pure lead in powdered form. Firstly, pure lead is put into the lead pot where temperature is generated by gas burner. When the temperature reaches at 450C, then the lead is melt. This malted lead is transferred from lead pot to ladle through a feed line using feed pump. There are electrical heaters in the feed line to keep certain temperature. By using dispense valve, timer controls the flow of lead from feed line to ladle. After that, the lead is transferred from ladle to plunger through a nozzle.

The solid cylinder of lead is found after one rotation of the system because there is a cooling system installed inside the cylinder-casting machine. The system is designed such a way that it can release the solid cylinder of lead to the elevator bucket, which is bringing the cylinder to reserve silo.

Now the function of the ball mill comes. The ball mill is actually used to crumble the lead cylinder. The ball mill can process certain amount of lead cylinder, for example 2500 kg of lead. When the crumbles of lead are released to the filter box then the weight of ball mill is reduced and the reserve silo motor is turned on by a signal coming from ball mill through the panel board. The silo releases some lead cylinder to the conveyer belt. Then the ball mill pulls the cylinder by negative force. At that time oxygen (air) reacts with lead cylinder to produces lead oxide. Due to friction in ball mill temperature can increase. So, normal water is poured on the top of the ball mill. For cooling purpose inlet key is used to control the incoming air, otherwise the ball mill will pull more cylinders. A block diagram of oxide mill is shown below:

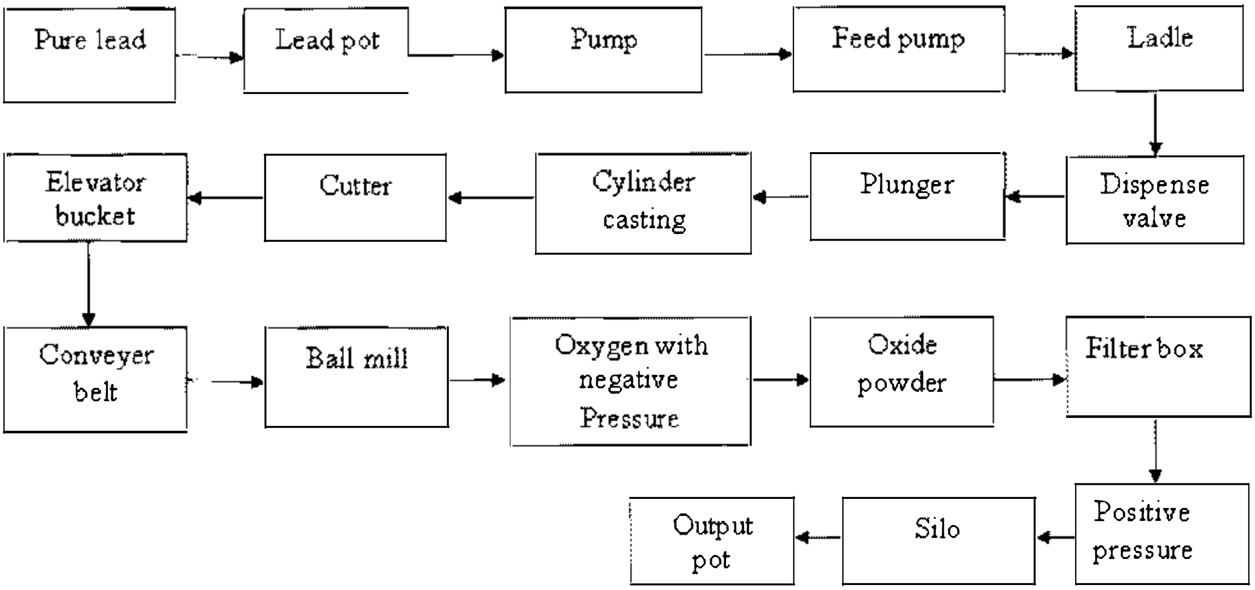


Figure 2.4: Block diagram of oxide mill

2.4.1 Different motors in oxide mill:

There is a motor in silo output, which is known as silo opening motor. It transfers the cylinder to the ball mill through a conveyer belt by a conveyer belt motor. Then the oxide powder is delivered to the filter box by using ball mill screw motor. On the top of the ball mill there is a motor called exhaust motor. In the filter box there is a filter blower, which is used for positive force. Header motor is used for up and down of the header with the filter in the filter box. Suction motor is used for sucking the air in the filter box, which is used for negative force. In the filter box, exhaust motor is used for exhausting purpose. The screw motor is used to open the transfer path to deliver the oxide powder from filter box to reserve silo. The elevator bucket motor is placed at the top on the reserve silo that is used to transfer the oxide powder to silo. The delivery motor is used to collect the oxide powder. There are 64 numbers of filters in the filter box.

2.5 August mixture:

The grid is surfaced with a paste which is made from powdered lead oxide produced by oxide mill. The paste is produced from the powdered lead oxide in August mixer. There are two kinds of pastes namely Positive paste and Negative paste. A sequence block diagram of August mixer procedure is shown below:

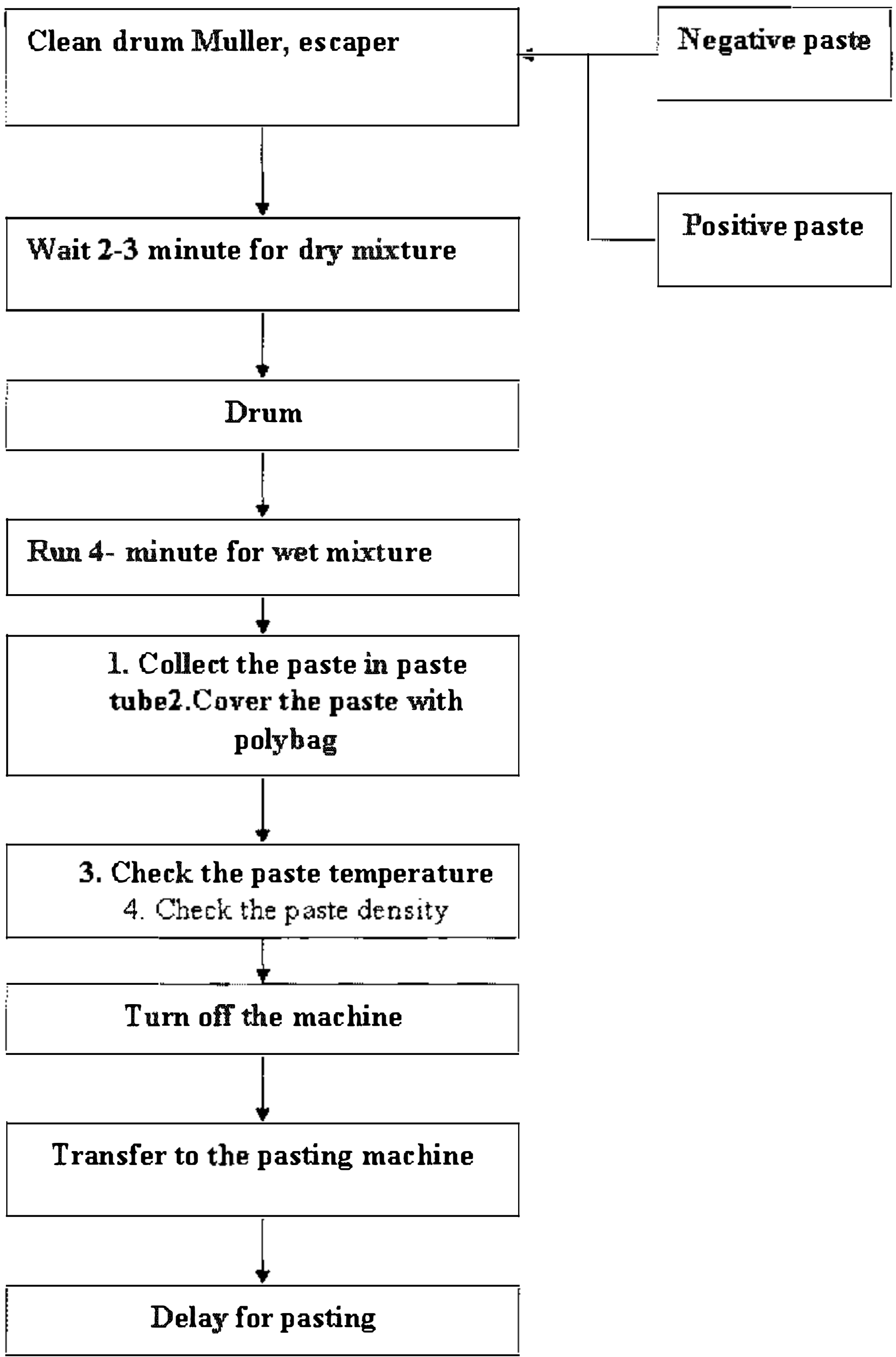


Figure 2.5: Block diagram of august mixer

2.5.1 Operation of escaper unit:

- To weight all ingredients for respective past mixture.
- To left water and acid in the overhead tank.
- To start mixing motor.
- To pour lead oxide in the mixing drum.
- To mix additives.

2.5.2 Operation of drum unit:

- To add water as early as possible, maximum 5 minute.
- To switch on air circulation.
- To open water valve for cooling drum.
- To add acid 2-3 L/m.

2.5.3 Materials of positive paste:

- Lead oxide: 600 Kg.
- Sulfuric acid: 45±1 liters. (Gravity of acid: 1340, 30C).
- Water: 78±3 liters.
- Flock: 360g.

2.5.4 Materials of negative paste:

- Lead oxide: 600 Kg.
- Sulfuric acid: 42±1liters. (Gravity of acid: 1340, 30C).
- Water: 72-75 liters.
- Flock: 360g.
- Indolin: 1200 gm.
- Carbon black: 1800 gm.
- Barium sulphate: 2400g.

Color of positive paste: yellow

Color of negative paste: Ash.

2.6 Pasting:

The lead grids are surfaced with the both positive and negative paste to produce the positive and negative plate respectively. The sequence block diagram of pasting is shown below:

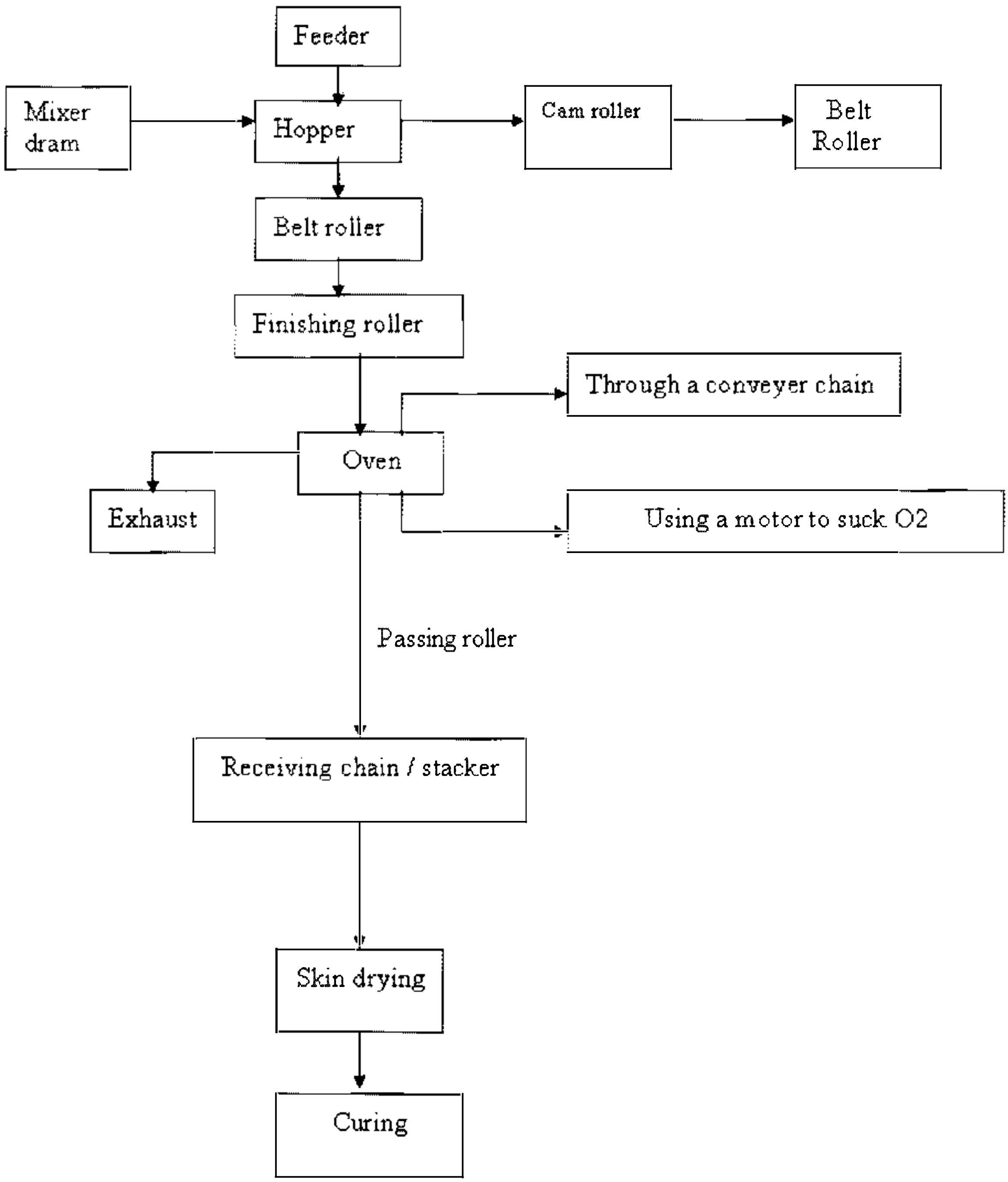


Figure 2.6: Sequence block diagram of pasting

2.7 Curing and conditioning:

Grids are being dried with skin drying process to remove the moisture from the plate to keep it under certain value. Grids are kept at 30-40 C for 16-22 hours for minimizing the moisture. This process is called curing. Curing process can be done manual or automatically. After curing, grids are kept at ambient temperature for 48 hours where moisture is maximum 1% and FLC (Free Lead content) is maximum 5%. This process is called conditioning.

2.8 Formation:

After curing and conditioning, formation process is being used for charging the both positive and negative plates. Here plates are dipped into the sulfuric acid mixer and the plates are charged using rectifier. This process continues up to18-22 hrs.

2.8.1 Description of formation rectifier:

The formation rectifier system is a controlled rectifier charger designed to meet the needs of tank and container fonnation charging of industrial batteries. Each system enclosure contains one independent constant current fonnation circuit utilizing full wave 3-phase rectification. Charging current is continuously adjustable from zero to the maximum rated current. Reversing the polarity is accomplished by selecting positive charge or negative charge with the positive charge or negative charge switch located on the system operator panel. Selection of the negative charge operation uses contactors to reverse the outputs leads, causing the battery voltage to reverse at the output terminals of the rectifier bridge. Negative charge current is continuously adjustable through the same range as the positive charge current.

2.8.2 Specification of formation rectifier:

- Input voltage 400 v AC 3-phase, 50Hz
- Maximum input power at rated output 85.1 KVA
- Output voltage maximum 150 DC
- Enclosures:
    1. One circuit per enclosure.
    2. 60” (1524mm) high x 44” (1067mm) wide x 48” (1219mm) deep.
    3. Estimated net weight 861 kg.
    4. Estimated air flow 318 CF

2.8.3 Control equipments of formation rectifier:

Operation controls of each circuit are:

- **Power on lamp** – lighted red when power is applied to the unit.
- Charge (+)/OFF/charge (-) switch – places the power rectifier in the charge positive or charge negative mode of operation.
- Current adjust – sets value of the charge current.
- **Digital current meter** – monitors the charge current.
- **Digital voltmeter** – monitors the battery voltage.
- **Manual/auto switch** – in the manual position the unit is controlled from the operators control panel. When in the auto position control is maintenance by an optional Microforms 9000 programmer.
- **Voltage and current test jacks-** monitors' battery voltage in dc volts and charging current in DC mili volts.

2.8.4 Fault protections of formation rectifier:

Each charging circuit is protected from damage due to open or short-circuited output.

If the fault is caused by excessive heat sink temperature, the heat sink temperature must drop below 65 C before the circuit restarts.

2.8.5 Efficiency:

For determining the charging efficiency, either the true operating power factor must be considered or power factor correction capacitors must be added to operate at the optimum level. As an example, an optimum power factor (95%) is needed for 92% efficiency.

2.8.6 Some features of the rectifier:

- **Construction:** Enclosure of the rectifiers is free standing which are installed side by side.
- **Accessibility**: Front and rear access doors are provided for service of internal components.

- **Airflow:** Cabinet is normally convection cooled, boost fans are provided in individual heat sink assemblies.
- **Environment:** System air input has to be acid free and with an input temperature at the top of the cabinet between 4 degree and 40 degree centigrade, humidity must be controlled to prevent condensation when equipment is ON or OFF.

2.8.7 Operating steps of formation rectifier:

Operating steps are given below:

- Turn off the 3-phase input power.
- Place man/ auto switch to the manual position.
- Set current pot fully counterclockwise.
- Connects formation tanks to the output terminals.
- Apply 3-phase input power to the unit.
- Place charge (+)/off/charge (-) switch to the desired mode charge (+) or charge (-).
- Turn current adjust for current flow. Observe current and voltage reading on meters.
- When the battery charging is finished, turn the current adjust to zero and place the charge (+)/OFF/charge (-) switch to the off position.
- The next set of batteries must be formed using the opposite charge (+) / charge (-).

2.8.8 Equipment setup:

A rectifier (model TIC500-1-150 v) is connected to 30 (maximum) series formation tanks (Vat). The procedures for initialization of the contact bars within the tanks must be followed to ensure proper contact of battery plate tabs before using formation. Not more than 3 plates should be inserted into any slot for automotive type plates. Industrial plates, which are considerably thicker, should be limited to one plate per slot. In any case, the plate must be able to fall freely within each slot to make contact with the bars at the base of the tank. All wire connections between tanks have to be well made and the wire size has to be sufficient to carry 500 A with minimum voltage drop.

For charging the plates positive or negative, we use rectifier. Firstly plates are dipped into H_2SO_4 (Gr1180). This arrangement is shown in figure 2.8.8. Here positive and negative plates are placed alternatively in the vat. All the positive plates are placed in such a way that all plates are connected to a bar, which is connected to the positive end of rectifier output. Thus negative plates are connected to the negative end of rectifier output. Thus we charge the plates for 20hr with required current. After completing the charge, the charged plates are transferred to the next process. After completing one cycle we change the plate arrangement. Here plates are placed alternatively but positive plates are placed on the bar, which was connected to the negative plates in earlier cycle and vice versa. We charge these plates for 30 minutes with polarity of earlier cycle. After 30 minutes, the polarity of charging is changed by a switch in rectifier which is known as reversing mode. A simple connection diagram of rectifier output and formation tank is shown below:

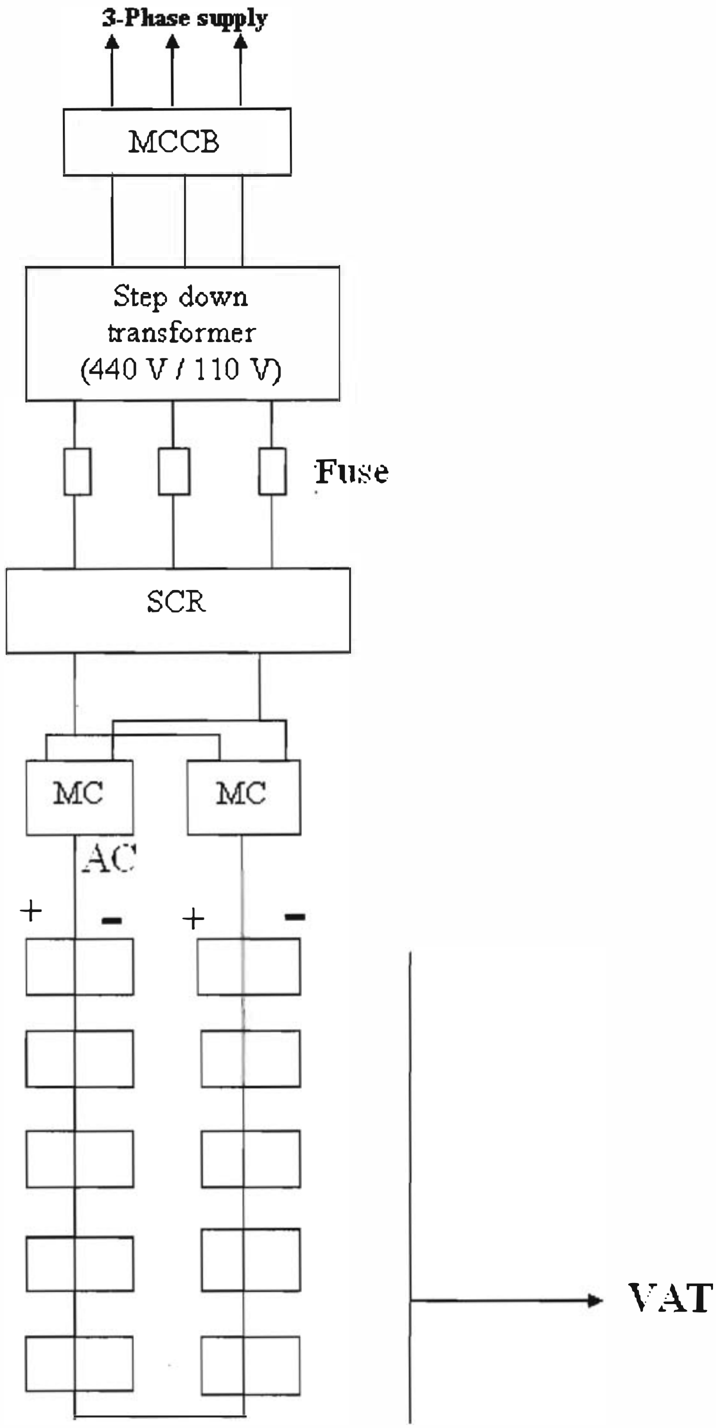


Figure2.8.8: Connection diagram of rectifier output with formation tank (Vat)

2.8.9 A calculation for current setting:

This calculation is only for positive plates.

1kg active material of the plate needs 330 AH current. Here plates are charged for 20hr (for one cycle).so current required for 1kg material /1h= 330/20

=16.5Amp

No. of plate per vat 'N'= 60pcs

Weight of paste per plate 'W'=272g

Current setting = N x W x K

= 60 x (272/1000) x 16.5 x 0.9

=242.4 amps

2.8.10 Automatic formation rectifier:

For charging plates another type of rectifier is used. It is controlled by computer. This equipment is composed of several charging / discharging circuit. The number of circuit depends on power of every circuit and the specific condition of user. Every circuit can independently set and work. This equipment can be used as charger or discharger, it can charge or discharge battery or other load.

The operating mode of this equipment takes digital setting, digital display, and proceeding control. Through the keyboard of computer user can set the parameter of charging or current, voltage, time etc. It is convenient for user because the different parameters of battery can be written in the computer provided by equipment. If power is switched off the computer will keep up these parameters. The equipment use LCD display system. The LCD display can display the number of proceeding voltage, current, time, operating conditions or fault message etc

In service / maintenance we can push down "pause" or "stop" button and stop the operation. If we push down "pause" the running state will pause but computer will memorize the working process or charging parameters .Then if we push down "start" button again, according to previous working process the equipment will run again

This equipment can automatically judge useful fault. When power lack of phase or inverting phase, over current, interrupting current etc occurs, it will give the message at LCD screen.

This equipment takes a typical RS-232 interface and supervisory software. The interface may be connected with serial interface of computer directly. It can connect many computers into a network; they are supervised by a central computer. The power parts of this equipment use air-cooling method, it does not need other special cooling device.

2.8.10.1 Electrical parameter of the rectifier:

Parameters of the automatic rectifier are given below:

Input AC power supply 420±10%, 50Hz ±5%

DC output voltage 10% ~100% rated voltage

Current 10% ~100% rated current

DC voltage output stabilizing accuracy ± 1%

DC current output stabilizing accuracy ± 1%

Working mode: charging, discharging

Time setting range: 0~99h 59m 59s

Current/time mode: it is constant current charging until the time is ending.

Voltage /time mode: Its constant voltage charging until the time is ending but the current is limited in range of setting current.

Current/ voltage mode: Constant current work until voltage exceeds setting voltage or the time is ending.

Zero current modes: static state only calculates time but it does not charge.

- Constant current discharging: it is constant current discharging until voltage fall bellow setting value or time is ending.
- Microcomputer control: digital setting, digital display, memory of function when lose power, it has printing interface, if provide any printer, you can print the data of charging or discharging process.

- Fault warning and fault display: Power fault, over current, over voltage, interrupting current, printer errors etc.
- It provides the communication interface of central computer.

2.8.10.2 Control system principle graph:

A simple block diagram of control system of the rectifier is shown below:

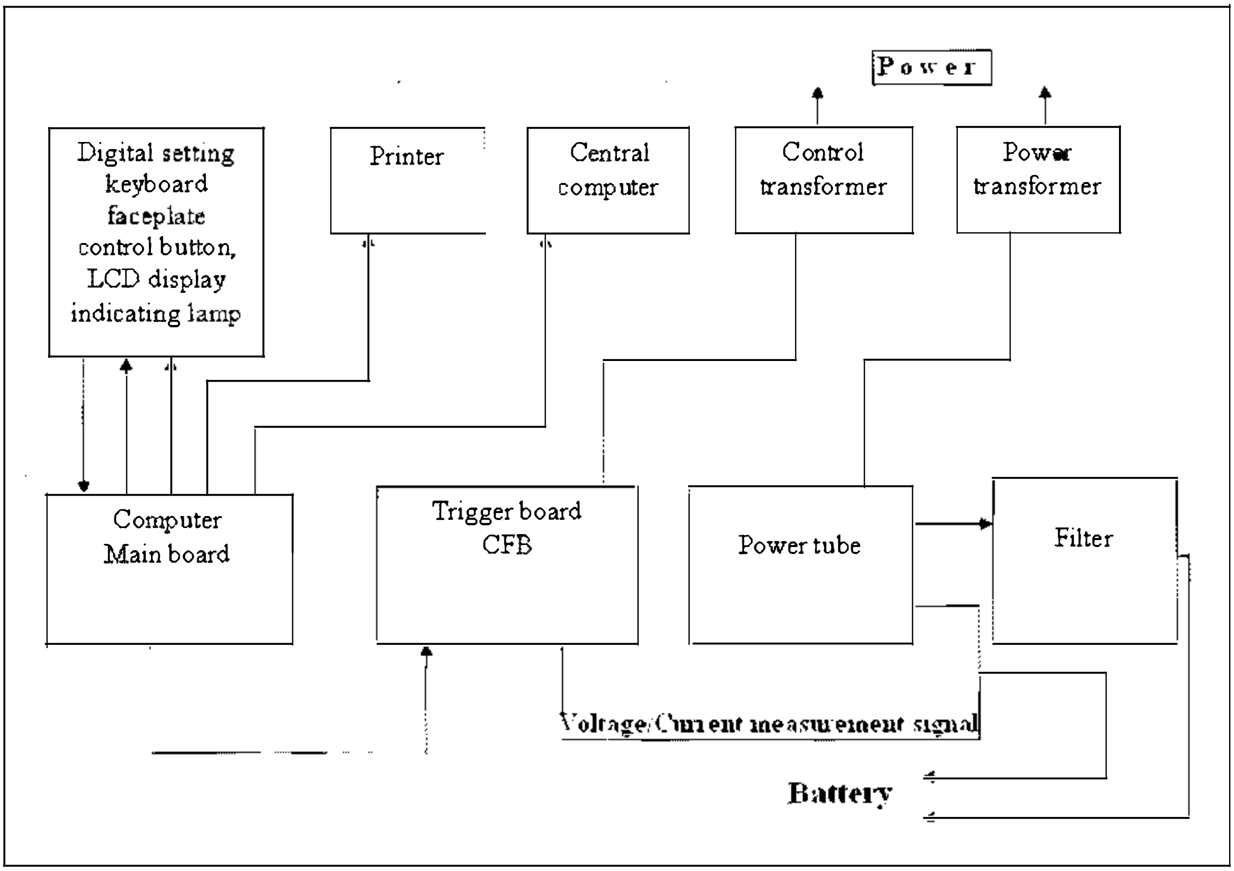


Figure2.8.10.2.a: Control system principle graph

Computer main board read out parameter setting value from faceplate, and accept control signal from control button, at the same time, send out display signal to LCD display, provide indicating signal for lamp, provide control signal to trigger board CFB, read out voltage/current signal and transform into digital value through A/D, then display with digit. In addition, the board provides a typical RS-232 interface connected with central supervisory computer.

A simple electrical diagram of a rectifier is given below:

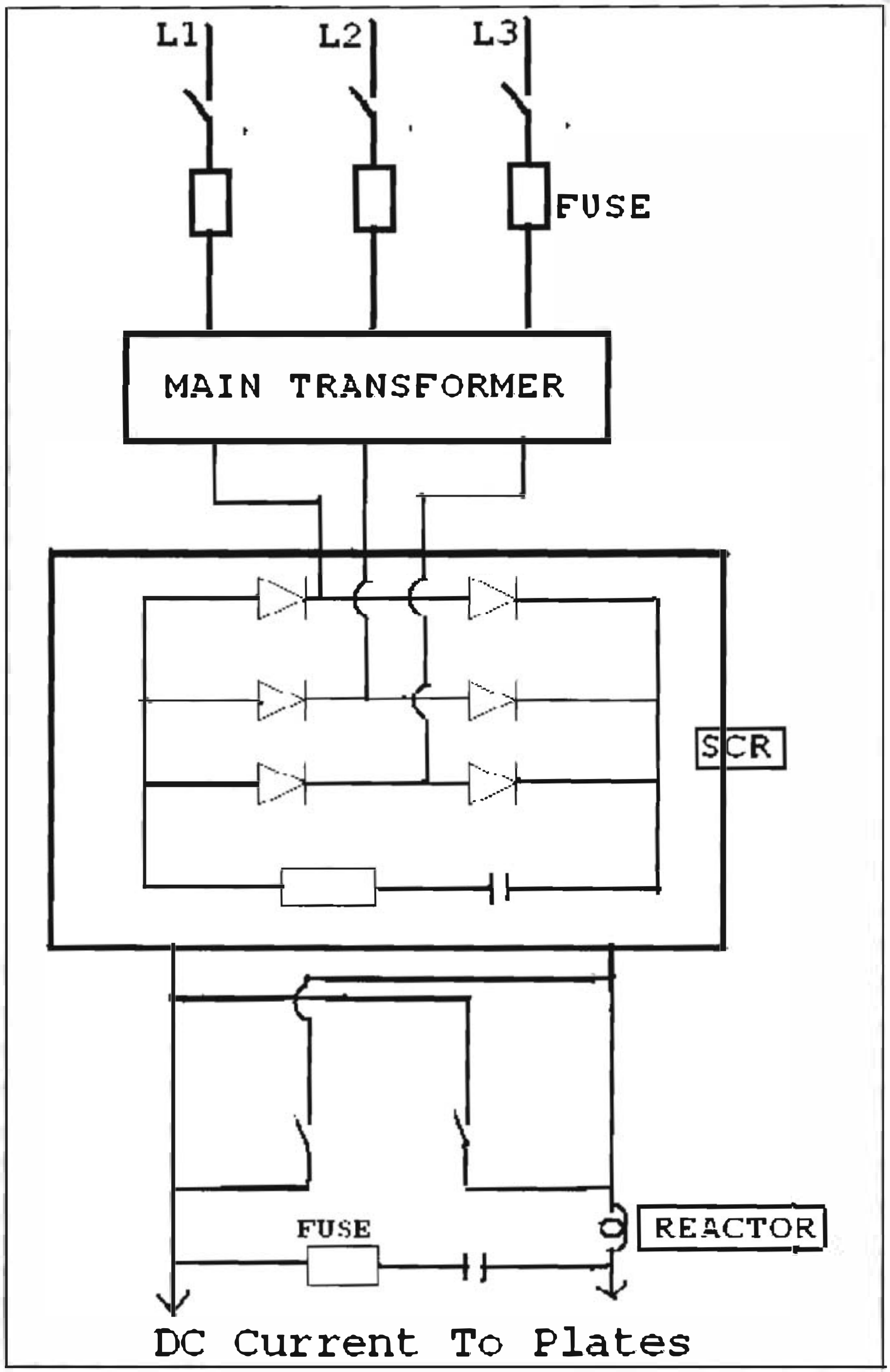


Figure 2.8.10.2.b: Electrical diagram of automatic rectifier

2.9 Positive dry oven (PDO)

When we complete the formation we need to take the positive plate to wash tanks for washing which contains water (pH above 4). Then keep the plate in the PDO for about ten hours at temperature 60-65 C in order to reduce moisture. The moisture has to be maximum 0.3%.

2.10 Inert gas oven (IGO)

After formation the negative plates are taken to the wash tanks to make them acid free. The tank contains water of pH above 6.5. They are kept in the IGO for about 75 minutes at temperature 76 degree Celsius. The drying of plates materially enhances the production of any given machine because of only the negative plates need to be derived in an inert gas / atmosphere. The cycle time of plate varies between 18 minutes to half an hour. Following steps are done for IGO:

- Remove plates from wash tanks.
- Preheat negative plate processor by turning on the heater for 10 minutes. Adjusts the thermistor.
- After testing one/two batch for the correct processing time, set timer for repeating the process.
- If desired, after washing the plates, the negative plates can be dipped into a pkotecto Solution for few minutes. After processing the plates will have a minute paraffin coating which will protect the dry plates against atmospheric humidity during storage.

Cautions for negative plates drying:

The wet negative plates (charged) should be exposed to the air for a minimum of time to prevent oxidation of the sponge lead. It is important that the processing of formed plates be started immediately at the end of the formation but not later than 1 to 1.5 hours (maximum).

2.11 Envelop separation:

As positive and negative plates are placed together with a very small separation in a cell, a separation is needed for avoiding sparks and any other undesired occurrence. So one kind of the plates [all positive or negatives] are inserted into envelops made of insulator material.

2.11.1 Envelop separator machine's mechanical switchgear:

A simple block diagram of Envelop Separator Machine is shown below:

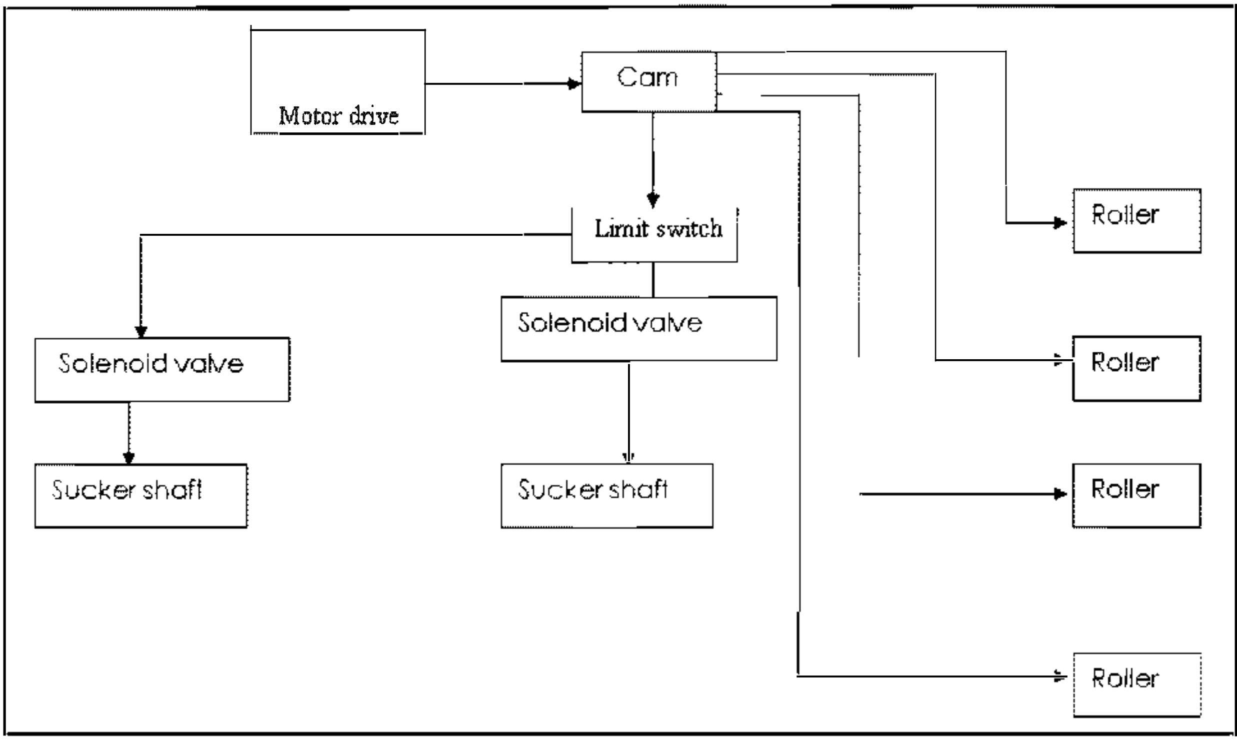
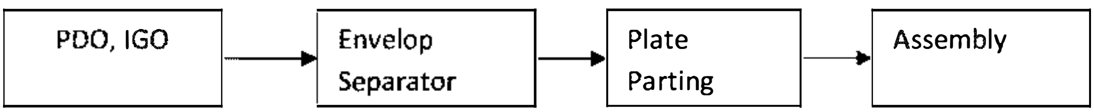


Figure2.11.1: Mechanical switchgear for envelop separator

2.12 Plate parting:



After drying, the positive & negative plates are transferred to the plate parting section. Here each plate is parting in two parts by using plate parting machine. At first the plate are placed on conveyer chain, which is connected with the brush. The brush is used for cleaning the plate. There are individual four brushes. Each two brushes are used for every separate parting plate (up side & down side). Then the plate is ready for cutting by mechanical cutter. The plate-parting machine is connected with the two separate delivery chain. Each chain is used to transfer the partitioned plate to the stacker or box. The exhauster line is connected with the parting machine to suck the dust and solid dust is manually collected for recycle. The operational sequence of plate parting is shown below:

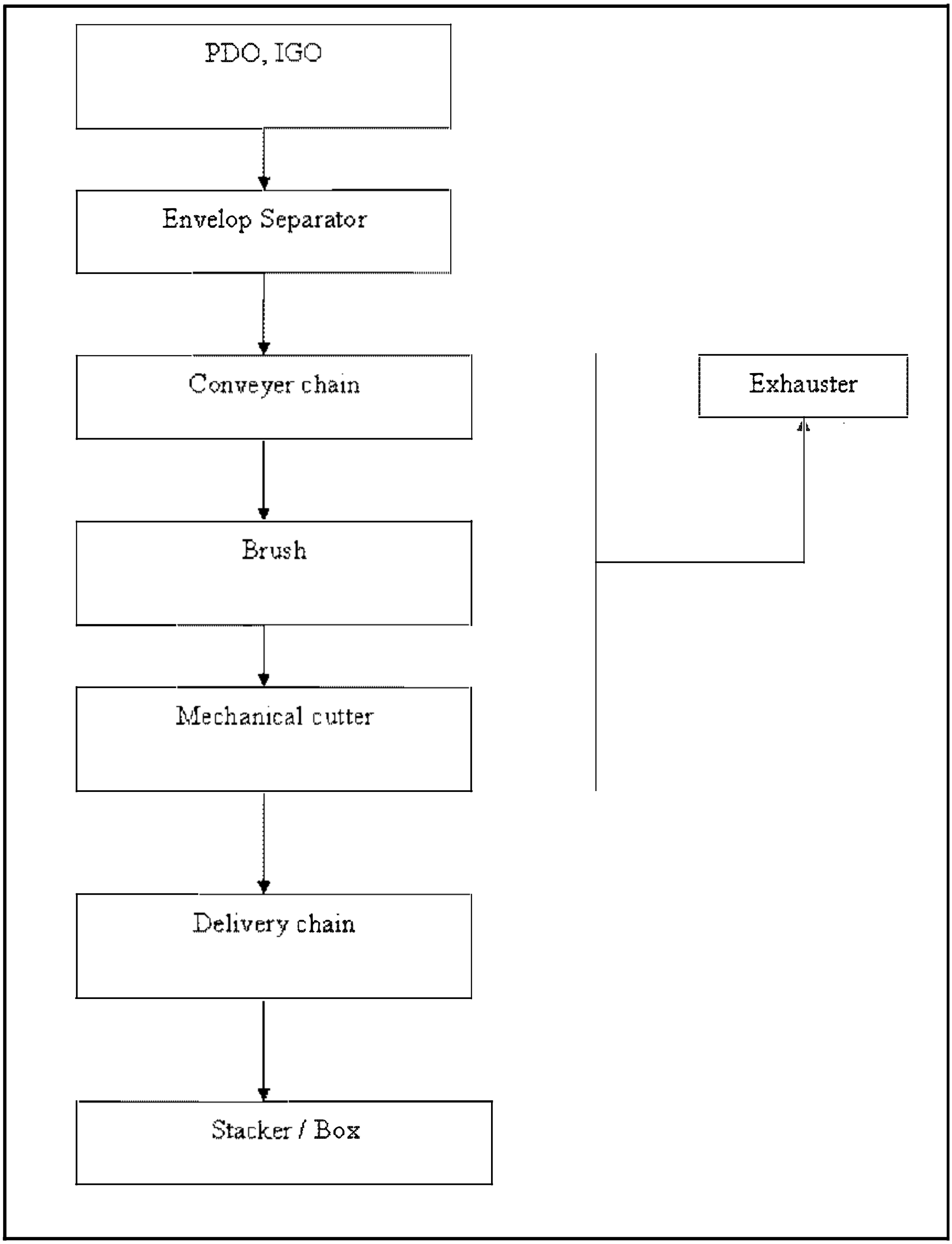


Figure 2.12: Operational sequences of plate parting unit.

2.13 Assembly:
The operational sequence of assembly section is shown below:

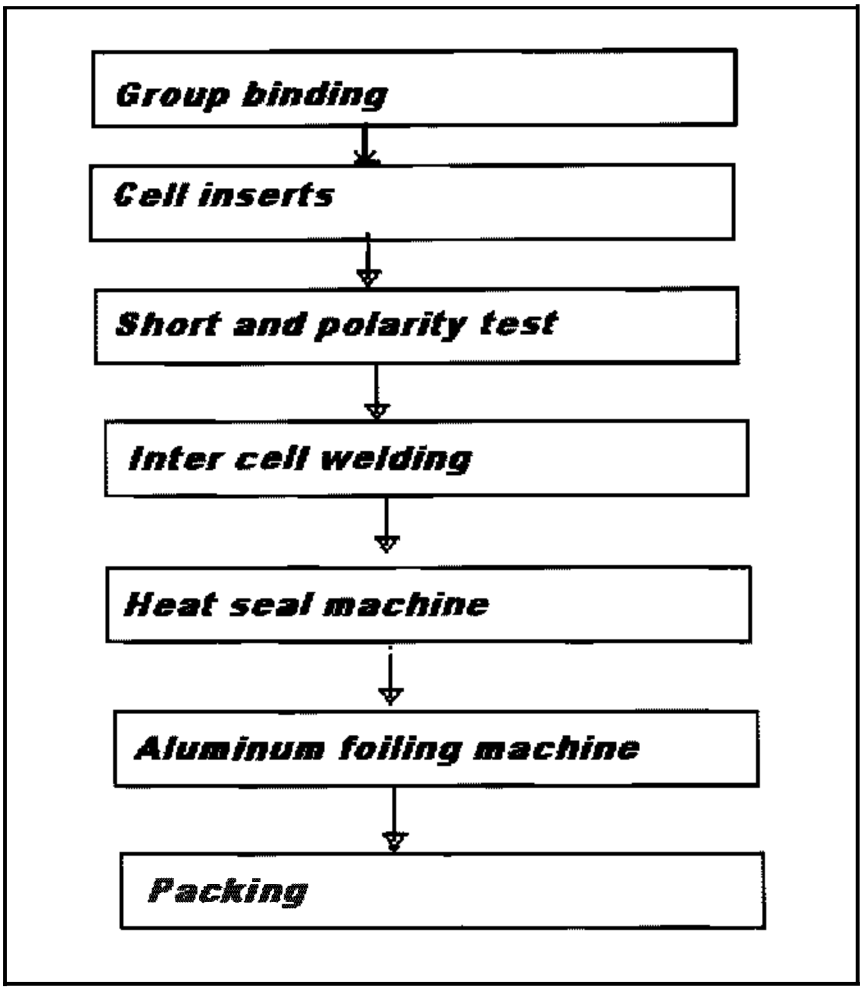


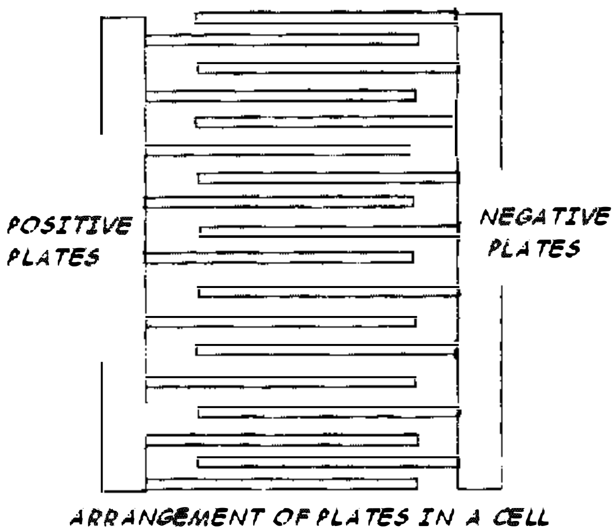
Figure 2.13: Operational sequence of assembly

2.13.1 Group binding:
Here plates are connected together using lead. Nine plates are attached together

So total plate required is 18 pieces (9 pieces positive & 9 pieces negative).

2.13.2 Cell insert:
A container of 12 V battery contains six cells. Each cell contains 18 pinches of plate, (positive nine plate and negative nine plates). Some potacium-sulphet powder is put into the container to maintain battery performance for a longer period of time.

The arrangement of plates in a cell and arrangement of cells in a battery container is shown below:



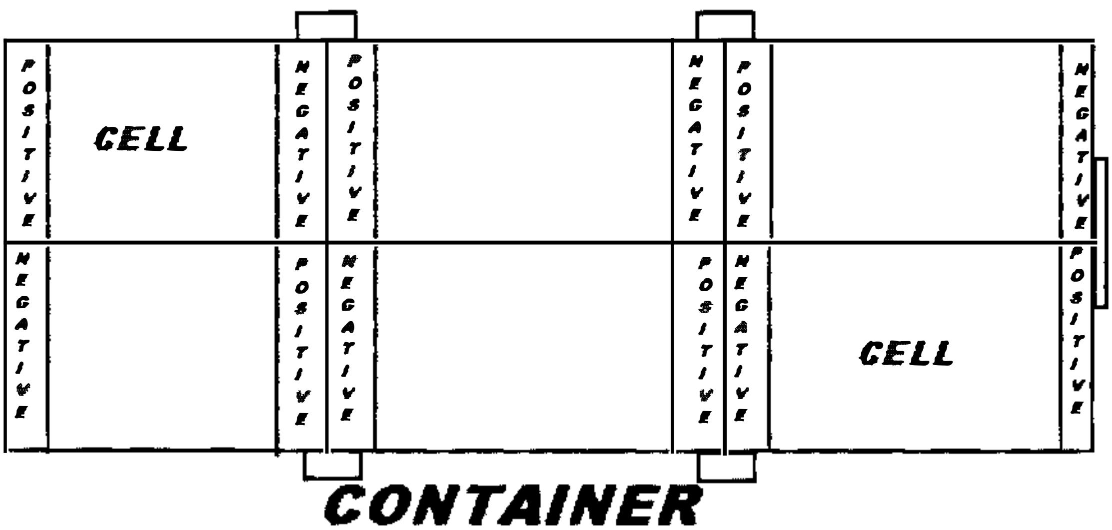


Figure 2.13.2: The arrangement of cell and connection of the plates in a battery container

.13.3 Short and polarity test

his process includes the checking of the polarity of cells and if there is any short connection ɜtween positive plate and negative plates.

2.13.4 Inter cell winding:

Here cells are connected together. Actually negative plate of one cell is connected to positive plate of next cell.

2.13.5 Heat seal machine:

After the completion of inter cell-winding the cover of the container is attached permanently with the container using heat seal machine.

2.14 Battery performance

This section includes different aspects related with the performance of the battery.

2.14.1 Background information about performance:

This section gives general background information on battery performance while other section deals with performance tests and other battery testing in more detail.

Battery performance is normally measured in "AMPERE HOUR". Thus the "AMPERE HOUR CAPACITY' is a measure of the quality of the battery that the battery can deliver.

1 ampere-hour = 1 amp flowing for 1 hour.

The battery capacity is dependent on the discharge rate and the quoted ampere-hour capacity must therefore also specify the rate of discharge e.g. a battery has a capacity of 40 ampere-hour (AH) when discharge at 2 amps. Usually capacity is expressed as. 40 AH at the 20-hour rate. This means that the battery will deliver a current of 2 amps for 20 hours.

For high rates of discharge, a '3 minute current' rating may be used: this is the maximum current at which the battery can be discharged to give a discharge time of three minutes.

The battery performance can be expressed in term's of its "WATT HOUR CAPACITY". This is a measure of the energy available, or the ability to do work.

The 'Watt Hour Capacity' = AHV * Avg. Voltage during discharge. To completely specify the battery capacity, one must also specify the final voltage or 'Cut-off' voltage at the end of the discharge. During the discharge, the battery voltage drops off slowly at first, then more rapidly. It is impractical to discharge the battery to zero volts, so, a 'cut-off' voltage is chosen at the 'knee' of the discharge curve where the rapid fall in voltage begins. To discharge beyond this oint would results in negligible extra performance being obtained. The actual cut off voltage hosen will be dependent on the discharge rate.

.g. 20 Hr rate Final voltage 1.75 volts/cell.

01 Hr rate Final voltage 1.33 volts/cell

03 minute Final voltage 1.00 volts/cell

Thus the performance of a given battery could be specified as 40 AH at the 20 hr rate, to a inal voltage of 1.75 volts per cell; or 20 AH at the 1 hr rate, to final voltage of 1.33 volts per cell. The performance of a battery and its voltage during discharge, are influenced by a number of variables. They are given below:

- The number of plates in the cell and the total amount of active material in the plates.
- Plate Thickness and Area
- Discharge Rate
- Temperature.
- Quantity and concentration of the electrolyte.
- Plate porosity
- Design of plates
- Previous history of plates

The influence of these factors on the battery performance is discussed more detailed below.

2.14.2 Amount of active material within the cell:

At low rates of discharge (e.g. 20 Hr rate) most batteries are limited in capacity by the total weight of the positive active material, and/or the amount of acid in the cell. The quantities of lead dioxide, lead and acid required for 1 ampere-hour capacity can be calculated from Faraday's law of electrolysis.

Thus 3.866g lead = 1 AH. 4.463g lead dioxide = 1AH 3.660g acid = 1AH

For a battery containing plates of a given size, the battery capacity can be increased or decreased by varying the number of plates, and adjusting the cell width in proportion. Since the positive plate limits discharge at low rates, this is chosen as a basis.

;. 9 plate battery (4 pos) 40 AH capacity i.e. 10AH per positive plate

7 plate battery (3 pos) 30AH
11 plate battery (5 pos) 50AH etc

:ilization of the plate active materials is rarely more than 50% for the following reasons.

- The lead sulphate formed during discharge is a non-conductor and increases the resistance of the plate active material.
- Blocking the plate pores by lead sulphate hinders electrolyte diffusion.
- The resistance of the electrolyte increases as the specific gravity decreases.
- There is limited contact between the grid and the active material.

Particularly at high rates of discharge, a cell with a lot of thin plates has greater capacity than ie same cell with fewer thick plates. This is because at high discharge rates the discharge :actions only penetrate partially into the plate, and the discharge reaction becomes a surface henomenon at the higher discharge rate. At very low discharge rates, there is time for acid to iffuse into the plate, and the capacity of thicker plates can then be utilized. The negative plates :e more sensitive to charges in thickness than the positive plates. Thus if at a high discharge rate ie capacity of the positive and negative plates are equal, the capacity of the negative will be xceed the capacity of positive at any lower rate.

.14.3 Discharge rate:

The battery capacity is dependent on the rate at which the battery is discharged. It delivers a ›wer ampere-hour capacity at the higher discharge rate. For example if a battery has a capacity f 40 AH at the 20 Hr rate, it will have a capacity of 35 AH at the 10 Hr rate on only 20 AH at ie 1 Hr rate. The main reasons for a battery that delivers a lower capacity at the higher ischarge rate are:

- Acid cannot diffuse into the pores of a lower plate quickly enough to sustain the discharge.
- Sulphation occurs on the surface of the plates, blocking the pores.
- There is a substantial voltage loss because of internal cell resistance.

he current and discharge time can be related together by 'Paukert's Equation':

$$I^n .t = C$$

C and n are constants, and can be evaluated by testing a battery at two different rates of ischarge. Thus if I_1 and I_2 are the two discharge rates, at t_1 and t_2 times:

$$I_1^n t_1 = C$$

$$I_2^n t_2 = C$$

o, $n \log I_1 = \log C - \log t_1$ or, $n = \log t_2 - \log t_1$

$n \log I_2 = \log C - \log t_2$ $\log t_1 - \log t_2$

Thus n and C can be calculated, and the equation can then be used to calculated the discharge me for any discharge rate (or vice versa)

A battery gave the following discharge time when discharge at the following current Constant temperature)

- Current 10 amps. Discharge time 2.5 Hours
- Current 100 amps. Discharge time 6minutes

1. What discharge time will the battery give when discharged at a current of 4 amps?
2. What will be the discharge current to give a discharge time of 3 minutes?

olution:

Jsing Paukert's equation, it is first necessary to calculate values for n and C, using the two ischarge currents and times given.

$= 100$ amps $t_1 = 0.1$ hours

$= 100$ amps $t_2 = 2.5$ hours

$= (\log t_2 - \log t_2) / (\log t_1 - \log t_2)$

$= (\log 2.5 - \log 0.1) / (\log 100 - \log 10)$

$= (0.3979 - (1.0000))/ (2-1)$

$= 1.3979/1$

o, $n=1.3979$

$$n \log I1 = \log C - \log t1$$

o $1.3979 * 2 = \log c - (1.0000)$

o $2.7958 = \log C + 1$

So log C = 1.7958

C = 62.48

a) Discharge current 4 amps.

n log I = log C – log t

1.3979 log 4 = log 62.48 – log t

1.3979 * 0.6021 = 1.7958 – log t

0.8427 = 1.7958 – log t

So, log t = 0.9541

So, t = 8.997 hrs

= 9 hours approx.

b) Discharge time = 3 minutes = 0.05 hrs

n log I = log C – log t

1.3979 log I = 1.7958 – log 0.05

= 1.7958 – (2.6990)

= 1.7958 + 1.3010

= 3.0968

So, log I =3.0968 / 1.3979 = 2.2153

So, I = 164.2 amps.

2.14.4 Temperature

This is a major factor in determining the capacity of a battery. The capacity is reduced at a low temperature and percentage of capacity at low temperature decreases as the rate of discharge increases. Chemical reactions do not take place readily at low temperature. Both voltage and discharge time are reduced at the lower temperature. At low discharge rates (10hr and 20 hr rate) the temperature coefficient of capacity is approximately 1% per degree C e.g. a battery discharged at 10 hr rate at 20 degree C will have a capacity 5% less than that at 25 degree C.

2.14.5 Quantity and concentration of the electrolyte

The concentration of the electrolyte has some effects on the performance of battery. Some probable effects are given below:

- It determines the potential of the plates
- It affects the resistance of the electrolyte to the passage of current.
- It affects the viscosity of the electrolyte and therefore the diffusion rate
- Differences in concentration of electrolyte in the plate pores and outside also affect the diffusion rate.

2.14.6 Porosity

Since the active material of the plates is highly porous, it is desired to alter the plate porosity by altering the paste density. Subsequent processing of the plate after pasting will also influence the plate porosity. The more porous the plate, the better it's performance, particularly at a high rate of discharge. However, for the positive plate, too high a porosity results in performance shedding service. Porosity of a typical automotive battery plate would be 45~55%.The approximate porosity of a battery plate can be calculated from knowledge of the plate dimensions, the actual weight of the plate and the density of the grid and active materials.

% Porosity = (1-apparent/Real density) * 100

The porosity also varies with the state of charge of the battery, the plate becoming less porous as the discharge proceeds and the plate pores become blocked with lead sulphate.

Normally a battery needs several cycles of charge and discharge to attain its maximum capacity. The capacities then remain fairly steady through the battery life, until the capacity decreases again towards the end of its useful life. Decrease in positive capacity towards the end of life is generally due to grid corrosion and active material shedding. The negative plate loses capacity primarily due to shrinkage of the active material and resultant loss of porosity. The capacity of a battery on a given discharge may also be influenced by the discharges immediately proceeding. The capacity is lower if preceded by a discharge at a higher rate and higher if proceeded by a discharge at lower rate. This is known as 'Hysteresis' Effects.

03 SPECIAL ASSAIGNMENT

·.1 Induced EMF in generator action:

According to faraday's Law, there are two ways for inducing "emf" in a coil namely: (1) ransformer action and (2) Relative motor action The generator actually follows the relative notion action. It states that when there is a relative motion between magnetic flux and coil, we et an induced emf in the coil. Now, the question is what direction the induced emf will follow. t is determined by the Lenz's Law. The law states that the induced emf (the associated flux) nust be in a direction that will develop a counter torque to oppose the driving torque of prime nover. The direction of the induced emf is shown below:

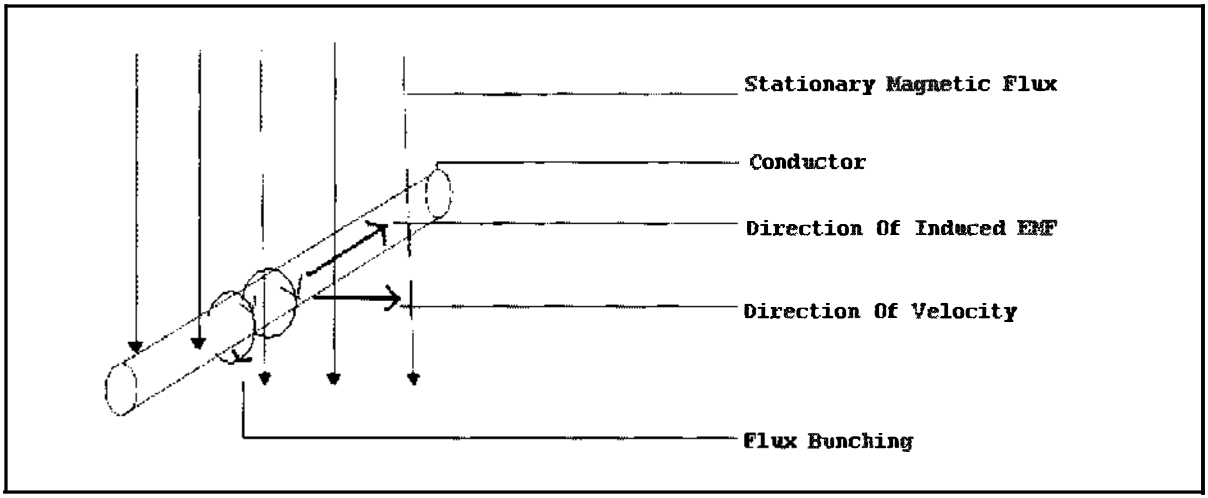


Figure3.1a: Direction of induced EMF in moving conductor in stationary magnetic field

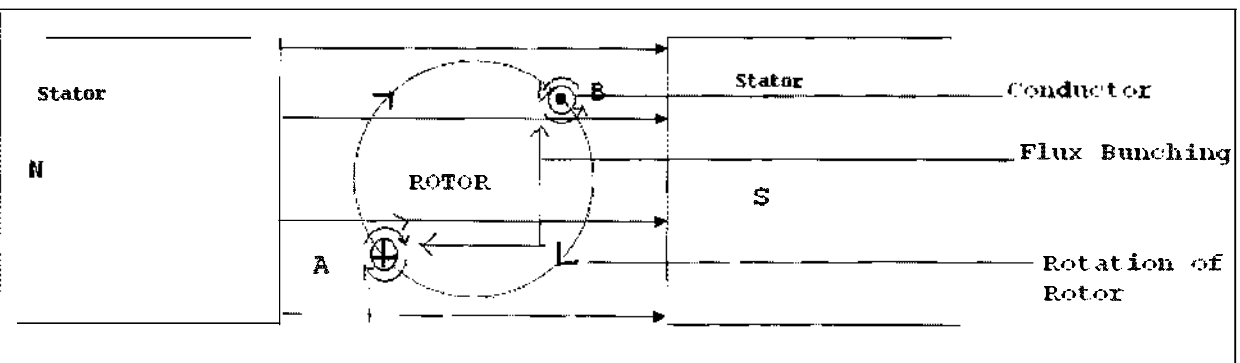


Figure 3.1b: Induced EMF in a two-pole generator.

.2 Magnetic contactor (MC):

A magnetic contactor is a mechanical switch in which the opening and closing of main contact achieved by means of electro-magnet. It is capable of making, carrying and breaking electric urrent under normal circuit condition including overload condition.

.3 Over load relay:

The purpose of thermal overload protection is to protect the motor insulation from excessive resses. During full load, the temperature of motor winding reaches almost maximum ermissible unit, which depends on insulation class. During abnormal condition the temperature ceeds the safe limit and life of insulation is reduced. A simple circuit connection of over load lay and magnetic contactor is shown below in figure 3.3.

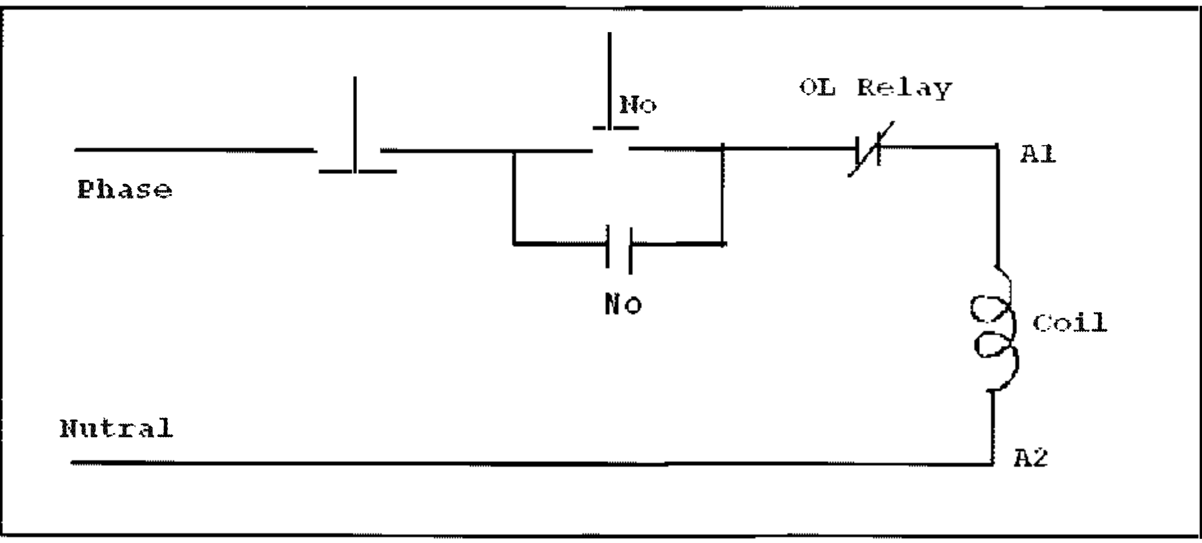


Figure 3.3: Connection of over load relay and magnetic contactor [3 phase connection]:

.3.1 Connection diagram of magnetic contactor and over load relay:

three phase connection diagram of magnetic contactor and overload relay is shown below:

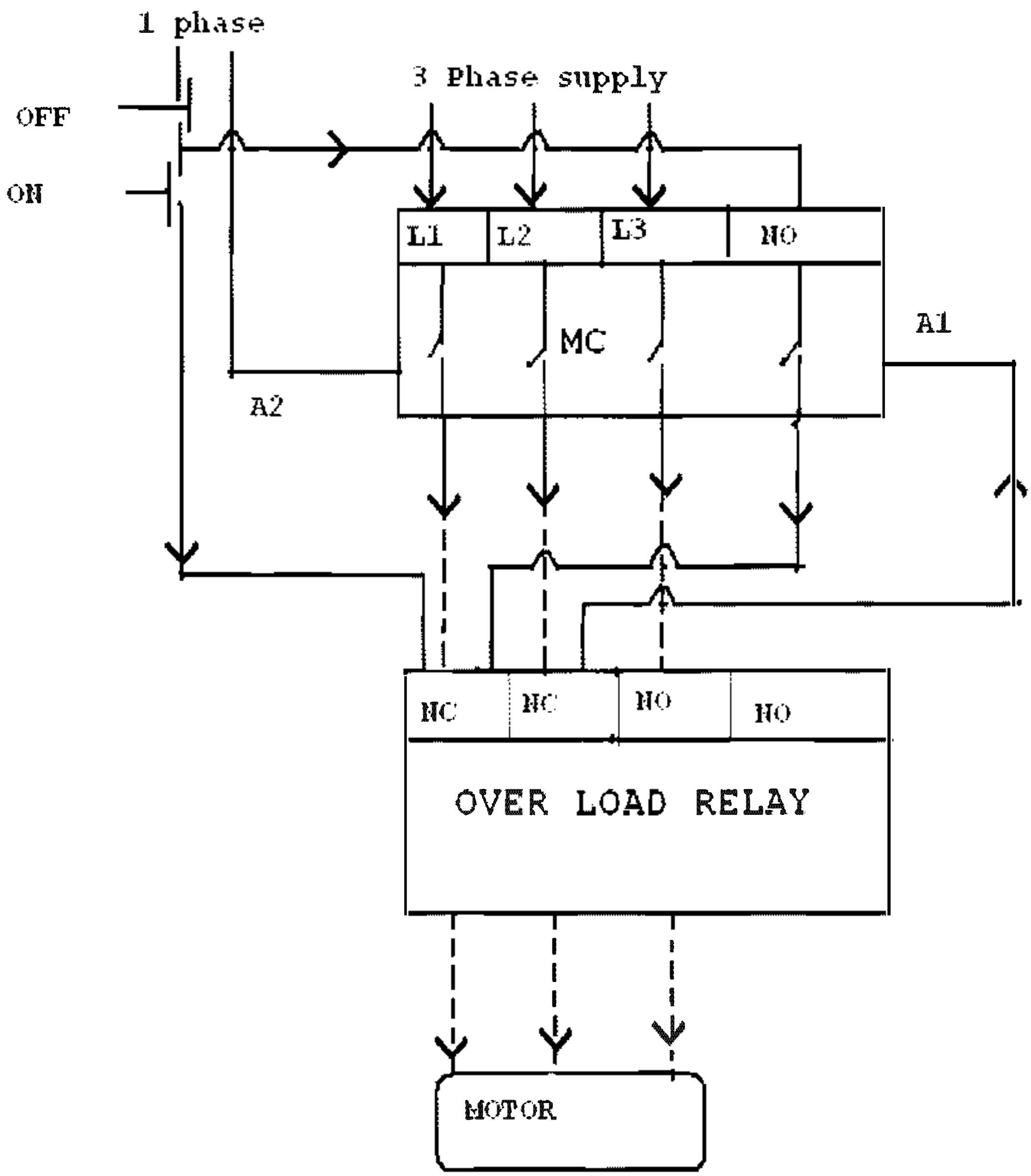


Figure 3.3.1: Connection diagram of magnetic contactor and over load relay

₃.4 Gas engine power plant

A basic diagram of engine generator is shown below

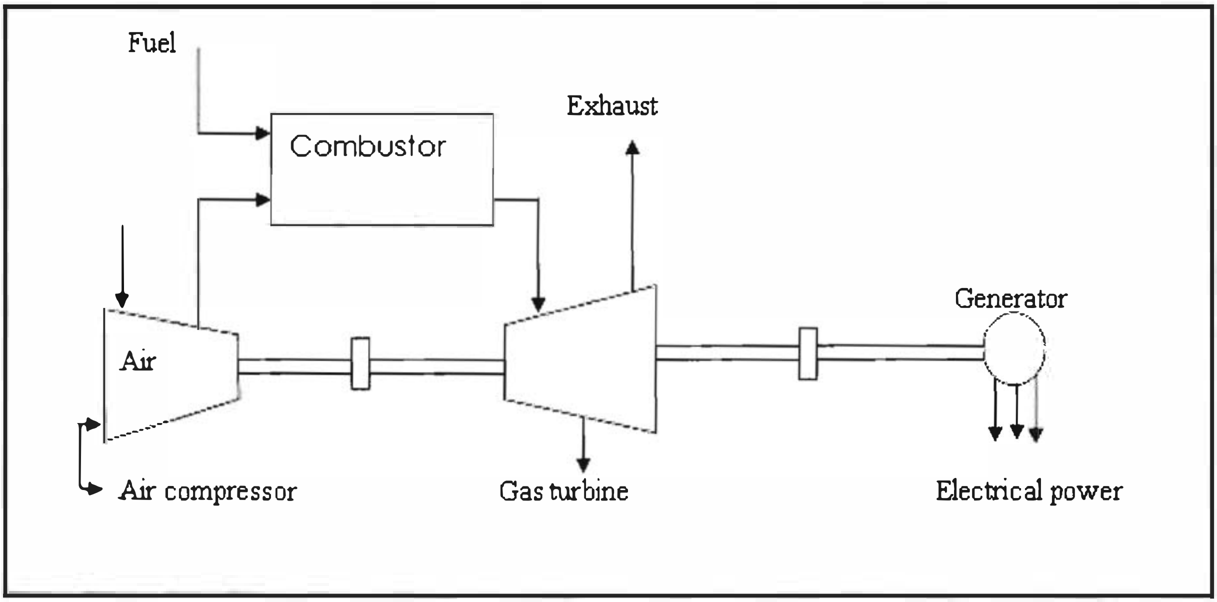


Figure 3.4: Basic diagram of gas engine generator

The gas power plant has the following part:

1. Air compressor
2. Fuel combustor
3. Gas turbine
4. Synchronous generator driven by Gas turbine

The other parts of the gas power plant are:

1. Turbo charger → two tasks: a) Compress the gas and air, b) Exhaust gas remove.
2. After cooler → cold the gas and air mixes.
3. Servo motor → used for controlling the flow of fuel mixing.
4. Engine(gas engine)
5. Armature rotor(generator)
6. Alternator
7. Control panel board.

Gas turbine generator units are produced in standard sizes in the range of 10MW (recently 250 MW).

.4.1 Advantage of gas turbine generator

he advantages of a gas generator are given below:

- It's easy to install.
- Low capital cost
- Quick to start
- Quick to load
- Quick to stop
- With modulator construction, least pollution hazards etc.

his is suited for:

- Peaking power plants.
- Emergency power plants.
- Standby power plants.
- Supply of auxiliary during peak loads.

.4.2 Block diagram of gas engine:

. block diagram of gas engine is shown below:

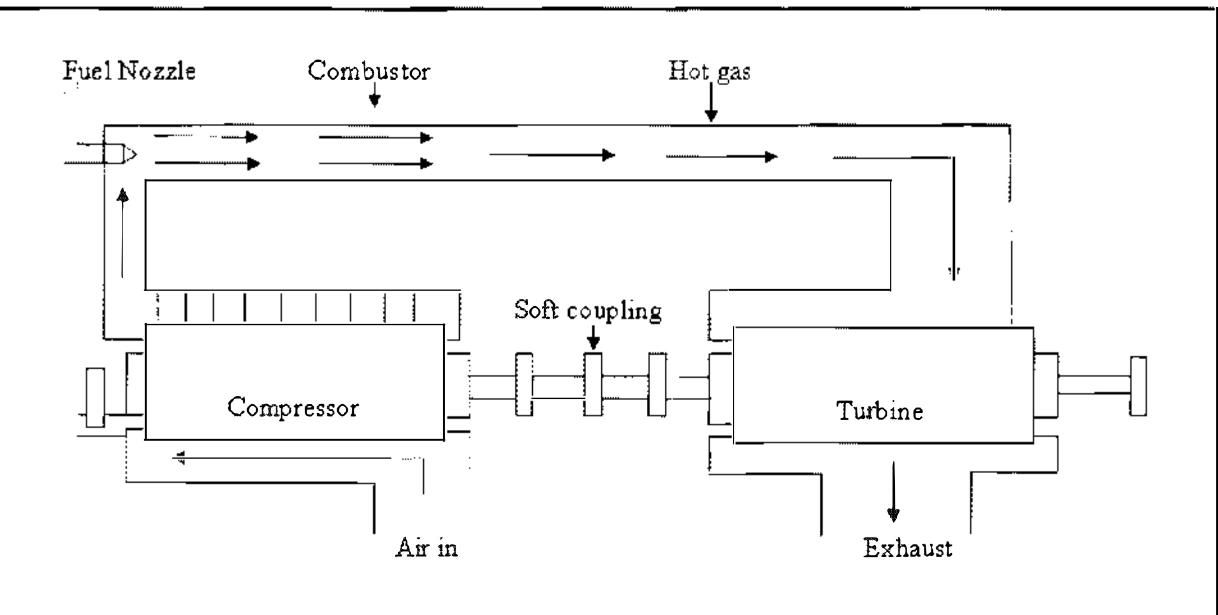


Figure 3.4.2: Block diagram of gas engine

The gas turbine drives the compressor and any load, such as a generator, fan or pump connecting at the load coupling. Atmosphere air enters the compressor inlet from below. The pressurized air leaves the compressor to enter the combustor. As the hot pressurized gas expands through the turbine stages, it develops the motive force for turning the turbine rotor.

As the gas leaves the turbine exhauster, its pressure drops to atmospheric pressure and temperature rises from 900 F to 1000 F. Gas turbine engines need additional equipment to serve the main components. This includes starting motors or engine, motor driven auxiliary lube pump, starting step up gear, fuel control system, oil coolers and filter, inlet and exhaust silencers and control panels.

The starting motors or engine drives the gas turbine and compressor through a clutch and step-up gear. During starting, stored compressed air expands the clutch member until it grips a clutch drum on the step-up gear.

3.4.3 Gas generator sets

Gas Engine models offer high reliability, durability, and fuel flexibility to burn fuels from the biomass to pipeline natural gas. Some features of gas generator are given below:

- Rating from 9 to 6000 KW.
- Low speed, high horsepower, low emissions
- Simple, robust design for long life
- Incorporates heavy-duty diesel components
- Robust digital ignition on most models
- High and low compression ratios available for greater fuel flexibility
- State-of-art Electronic Ignition System & Engine Supervisory System
- Delivers up to 100,000 hours between major overhauls

3.5 Load distribution for a battery industry:

The power generated in gas power plant is distributed among different units according to their required load. A list of loads for different machine and units are shown below:

Table1: Load distribution

Serial no	Name of m/c	Rated power
1	Grid casting machine	Wirtz 18.5 KW Yuasa 33 KW Diam 11KW
2	Oxide mill	80 KW
3	Paste mixer	4.15 KW
4	Pasting	13 KW
5	Curing chamber	4 KW
6	Formation (per circuit)	25 KW
7	Positive ryoven(PDO)	20.2 KW
8	Inner gas oven(IGO)	5.96 KW
9	Plate partition	23.15 KW
10	Assembly	92.11 KW
11	Oxygen generator	30 KW
12	Utility	31.4 KW
13	Water pump	15 KW
14	Compressor	49 KW
15	Maintenance	35.1 KW
16	Plastic molding	50 KW

04 CONCLUTION:

In this report our main objective is to appraise the practical knowledge, information and understandings that we have acquired from exploring several electrical equipments and machines, discussing with knowledgeable engineers and technicians. Here we have tried to share the knowledge of how electrical energy is converted to mechanical energy in industrial applications. We have also talked about electrical protections of some equipment and have also provided a simple overview of the making process of the Lead-Acid battery.