ABSTRACT

Automobiles are run by fuels like diesel and petrol. But the fuel releases the harmful gases and pollutes the atmosphere. Now a days the fuel cost also increased, and the maintenance of the vehicle is also difficult. To reduce the pollution batteries, motors & controllers are used to run the vehicle. Because it is less cost and maintenance are easy, as compared to ordinary automobiles. In these vehicles' fossil fuels are not used, so there is no global pollution. Electrical vehicles and battery electrical vehicles, hybrid electrical vehicles are the most common used automobiles in transportation now a days.

The main objective of the project is to modify **MAHENDRA LOGON DIESEL POWERED CAR** to the battery e-car by dissembling the engine & engine components and by arranging the 3KW motor, 60V batteries to run the vehicle in forward and reverse direction and with high mileage and speed for the daily use. So that they can travel a fixed distance that they need to commute every day on a reliable and economical car that essentially runs on free rechargeable batteries energy.

In this project, modification of transmission system, braking system, roof of the car, alignment of wheels and painting is done as per the requirement for remodelling of **MAHENDRA LOGON** car. Finally, this project is remodelled with reverse and forward moments with arrangement of wiring system, control panel for proper run of the vehicle and project is concluded by checking mileage & speed with respect to battery charging & with cost analysis.

Chapter – 1

INTRODUCTION

1.1 INTRODUCTION:

Today's globalized market competitions among the various automobile industries drives the automotive creators to design their commodities specific to consumer's choices and satisfaction. The interior environment of a car is categorized as a confined workstation in which the drivers are required to adapt and perform the driving tasks. To reduce the cost consuming for fuel we provides batteries to run the vehicle. In this project we are dissembling the engine and arrange the 48 volts batteries and 2KW power motor with modifications of braking system.

A Motorized vehicle (MV), also referred to as an electric drive vehicle, uses one or more electric motors or traction motors for propulsion. Electric vehicles include electric cars, electric trains, electric Lorries, electric airplanes, electric boats, electric motorcycles and scooters and electric spacecraft.

A Motorized vehicle is vehicle with an attached motor used either to power the vehicle, or to assist with pedalling. Sometimes classified as a motor vehicle, or a class of hybrid vehicle, motorized vehicles may be powered by a variety of engine types and power sources.

Electric vehicles first came into existence in the mid-19th century, when electricity was among the preferred methods for motor vehicle propulsion, providing a level of comfort and ease of operation that could not be achieved by the gasoline cars of the time.

The internal combustion engine (ICE) is the dominant propulsion method for motor vehicles but electric power has remained commonplace in other vehicle types, such as trains and smaller vehicles of all types.

During the last few decades, environmental impact of the petroleum-based transportation infrastructure, along with the peak oil, has led to renewed interest in an electric transportation infrastructure. Electric vehicles differ from fossil fuel-powered vehicles in that the electricity they consume can be generated from a wide range of sources, including fossil fuels, nuclear power, and renewable sources such as tidal power, power, and wind power or any combination of those.

Currently though there are more than 400 coal power plants in the U.S. alone. However, it is generated, this energy is then transmitted to the vehicle through use of overhead lines, wireless energy transfer such as inductive charging, or a direct connection through an electrical cable.

The electricity may then be stored on board the vehicle using a battery, flywheel, or super capacitors. Vehicles making use of engines working on the principle of combustion can usually only derive their energy.

A key advantage of electric or motorized electric vehicles is regenerative braking and suspension; their ability to recover energy normally lost during braking as electricity to be restored to the on-board battery.

In 2003, the first mass-produced Motorized gasoline-electric car, the Toyota Prius, was introduced worldwide; in the same year Going Green in London launched the G-Wiz electric car, a quadric cycle that became the world's best-selling EV.

1.2 TYPES OF ENGINES:

An engine or motor is a machine designed to convert one form of energy into mechanical energy. Heat engines convert heat into work via various thermodynamic processes.

Fig 01: Engine

There are two types of engines, namely

1. Internal combustion engine
2. External combustion engine

1. INTERNAL COMBUSTION ENGINE:

An internal combustion engine (ICE) is a heat engine in which the combustion of a fuel occurs with an oxidizer (usually air) in a combustion chamber that is an integral part of the working fluid flow circuit. In an internal combustion engine, the expansion of the hightemperature and high-pressure gases produced by combustion applies direct force to some component of the engine. The force is applied typically to pistons, turbine blades, a rotor, or a nozzle. This force moves the component over a distance, transforming chemical energy into useful work. This replaced the external combustion engine for applications where weight or size of the engine is important.

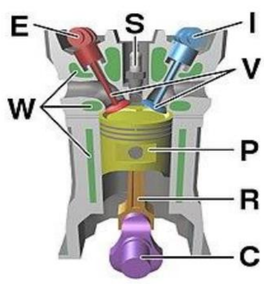


Fig 02: Internal combustion engine

2. EXTERNAL COMBUSTION ENGINE:

An external combustion engine (EC engine) is a heat engine where a working fluid contained internally is heated by combustion in an external source through the engine wall or a heat exchanger. The fluid then, by expanding and acting on the mechanism of the engine produces motion and usable work. The fluid is then dumped (open cycle), or cooled, compressed and reused (closed cycle). In these types of engines, the combustion is primarily used as a heat source and the engine can work equally well with other types of heat sources.

1.3 ENGINE COMPONENTS:

Engine is the main automotive component for any automobile. It works as a heart of automobile. A lot of research has been made to improve performance of automobile engine by improving engine components. Some very important engine components in modern automobile engines are engine block, flywheel, crankshaft, piston, etc.

• Crankshaft • Cylinder Head • Flywheel • Cylinder Block • Carburettor • Piston • Exhaust Valve • Timing Belt Cover • Connecting rod • Timing Belt • Catalyst Converter • Oil Seal • Turbo Charger • Fuel Tank • Sensor • Intake Manifold • Water Pump • Exhaust Manifold • Fan • Radiator • Spark Plug

• Fuel Injector • Oil Pump

1.4 HISTORY OF ELECTRICAL VEHICLE:

The invention of the first model electric vehicle is attributed to various people. In 1828, Anyos Jedlik invented an early type of electric motor, and created a small model car powered by his new motor. Between 1832 and 1839, Scottish inventor Robert Anderson also invented a crude electric carriage

Fig 03: Anyos Jedlik invented car

Electric vehicles were among the earliest automobiles, and before the pre-eminence of light, powerful internal combustion engines, electric automobiles held many vehicles land speed and distance records in the early 1900s. They were produced by Baker Electric, Columbia Electric, Detroit Electric, and others, and at one point in history out-sold gasoline-powered vehicles.

1.5 ELECTRICITY SOURCES:

There are many ways to generate electricity,

Different Sources of Energy

- Solar Energy - The primary source of energy is the sun
- Wind Energy - Wind power is becoming more and more common
- Geothermal Energy
- Hydrogen Energy
- Tidal Energy
- Wave Energy
- Hydroelectric Energy
- Biomass Energy

Also, some sources are there more ecological,

- On-board Rechargeable Electricity Storage System (RESS), called Full Electric Vehicles (FEV)

- Chemical energy stored on the vehicle in on-board batteries – Battery Electric Vehicle (BEV)
- Renewable sources such as solar power: solar vehicle

Chapter -2

LITERATURE REVIEW

2.1 LITERATURE:

Kurani et al. (2016): Online survey and interviews to measure buyers' awareness of EVs and understand their decision making. Addressing broader consumer awareness is the first step to expand the ZEV market. Just 49% of survey respondents were aware of federal incentives; 33% of respondents were aware of the CA state incentive. EV model recognition has not spread beyond early models. Individuals with greater familiarity and experience with EVs are more likely to value ZEVs higher.

Bailey et al. (2015): Investigation of whether visibility of public chargers has an impact on PEV demand. There is no significant relationship between perceived existence of one charging station and PEV interest; however, there is a weak yet significant relationship between perceived existence of multiple charging stations and PEV interest.

Bunce et al. (2014): Questionnaires and interviews to assess drivers' attitudes and experiences driving an EV before and after a three-month trial. Before a three-month trial, 51% of drivers were willing to pay more for a less environmentally damaging vehicle. After the trial, 74% of drivers expressed willingness.

Cahill et al. (2014): Interviews with automakers and dealers, and analysis on customer satisfaction data. Overall, consumer experience at dealerships is much better for conventional vehicle buyers than PEV buyers. Introducing new methods for educating and scaling dealer competence regarding electric vehicles could greatly improve the consumer experience.

Krause et al (2013): Survey analysis examines consumer knowledge of PEVs and current public policies. Most survey respondents were misinformed regarding basic PEV characteristics. Nearly 95% of respondents were unaware of state and local policies. Misperceptions regarding potential fuel and maintenance cost savings can notably hinder PEV interest.

Vyas & Hurst (2013): Web-based survey and analysis of results to understand consumer attitudes toward BEVs and PHEVs. Fewer than 50% of survey respondents were familiar with the Chevrolet Volt, compared to 31% with the Nissan Leaf, and below 25% for Tesla Model S, Ford C-Max Energi, and BMW i3.

Egbue & Long (2012): Survey that samples technology enthusiasts to determine attitudes toward EVs Consumer attitudes and uncertainty regarding EV battery technology and sustainability of fuel sources may be a barrier to widespread adoption; this uncertainty may stem from lack of understanding and familiarity.

Gyimesi & Viswanathan (2011): Interviews with executives from auto companies and survey of consumers to understand their attitudes towards EVs. 45% of the drivers they surveyed have little to no understanding of EVs Consumers with better understanding are generally more willing to pay a premium for the technology. Nevertheless, even well-informed consumers are sometimes unaware of the lifetime fuel savings that EVs offer.

Kurani et al. (2009): A trial was carried out followed by interviews and surveys to reveal consumer behaviours. Major themes included driving behaviour, recharging habits and etiquette, confusion about PHEVs and their operation, and potential cost savings. The trial identified that drivers accrue information and develop complex ideas about the technology and its possible impact on lifestyle.

Lutsey et al. (2016): "Identifies actions being taken by state and local governments and public utilities to facilitate electric vehicle deployment in the 50 largest U.S. metro areas, as well as city-specific analysis." **California (2015):** "An updated roadmap to CA's ZEV goal."

Frades (2014): "DOE/C2ES report summarizing the work of a series of projects carried out by the awarder organizations and partnering coalitions."

NASEO (National Association of State Energy Officials) (2013): "Explores perspectives from stakeholders, strategies for increasing EV deployment and lessons learned in outreach."

Chapter-3

MOTORS

3.1 INTRODUCTION:

Fig 05: Electric Motor

An electric motor is a machine that uses the concept of conversion of energy and consequently converts electric to mechanical energy. The main parts that help propel the process are the rotor, stator, windings, air gap and commutator. The approximate efficiency of an electric motor is 70%-85% (extra energy is taken by the sound and heat emitted by it). Whether for tasks as huge as building high rises, to ones as commonplace as warming food, electric motors play a significant role in our lives. Uses of Electric Motors Electric motors, both large and small, can be used in a number of ways in residential and industrial applications.

- At home, they can be used as water pumps for a number of different reasons such as central heating, fish tanks, etc. Moreover, there are a lot of electrical appliances at home that use electric motor, like food processors, DVD drives, garage door openers, power windows, etc.
- On the field, some examples of electric motors include mills, lathes, fork-lift trucks, extruders, etc. A lot of work is dependent on these machines.

How is an Electric Motor Installed?

Here are the general and specific requirements that need to be followed in order to install an electric motor,

General Requirements

- ❖ The environment impacts the kind of motor that needs to be installed.
- ❖ All Variable Frequency Drive controlled motors must be rated by IEC or NEMA inverter duty.
- ❖ Article 430 of NEC must be complied with.
- ❖ If the nameplate of the motor is hidden or unclear after installation, a new one must be put up someplace where it can easily be seen.
- ❖ Special consideration has to be given to the insulation limits and if the motor is installed at a height.
- ❖ If the surface temperature exceeds 60 C, the motor needs to be provided with guarding
- ❖ Clear signs and arrows should be propped up so that no reverse-rotation scenarios occur, causing health hazards or equipment damage.
- ❖ RTDs and a temperature relay system are necessary for motors using above 55 kW, so they shut down if very high temperatures are reached.
- ❖ Certain performance characteristics needed to be adhered to with an S1 duty rating.
- ❖ A wire made of stranded copper must be ground insulated in the motor, with one end in the control panel that has the motor starter.
- ❖ In case of any special usage warrants or motors that require a different duty fee from those stipulated above, a P&G-certified electric engineer must be notified.
- ❖ Connection of the motor through wire nuts is prohibited except for certain exceptions.
- ❖ Boxes that contain the motor junction are supposed to be made of metal.
- ❖ Continuous motor leads are expected with a ground wire running along.
- ❖ A motor must have a service factor of at least 1.15 if it is to work continuously or in an environment where the temperature exceeds 40C.

Specific Requirements

There are 3 kinds of specific requirements that you need to keep in mind:

1) Global: All AC motors are to be made for 50/60 Hz and 400 VAC, and a Variable Frequency Drive is imperative for AC motors.
2) U.S. Only Tools: The design of such motors must adhere to 60 Hz and 460 VAC. Moreover, those that are not controlled by VFD and with 0.75 HP or higher power rating need necessary protection for thermal overload. Those below 0.75 HP are encouraged to get overload protection.
3) E.U. Only Tools: The motor designs must correspond to 50 Hz and 400 VAC. The rest of the requirements coincide with those of U.S. Only Tools.

3.2 TYPES OF MOTORS:

The electric motor is mainly classified into two types. They are the AC motor and the DC motor.

1. DC Motor - The DC motor takes direct current as an input.
2. AC Motor - The AC motor takes alternating current as an input.

DC Motors

Brushed Motors

Brushed motors comprise four main components:

❖ Stator
❖ Rotor or Armature
❖ Brushes
❖ Commutator

There are four main brushed motor types, including:

❖ **Series Motors:** The stator is in series or identical with the rotor, causing their field currents to be identical. Characteristics: used in cranes and winches, great low-speed torque, limited high-speed torque.
❖ **Shunt Motor:** The field coil is parallel (shunt) with the rotor, making the motor current equal to the sum of the two currents. Characteristics: used in industrial and automotive applications, excellent speed controls high/consistent torque at low speeds.
❖ **Cumulative Compound Motors:** This type combines aspects of both series and shut types, making the motor current equal to the sum of both the series field and shunt field currents. Characteristics: used in industrial and automotive applications, has combined benefits of both series and shunt motors.
❖ **PMDC Motors (Permanent Magnet):** The most common type of brushed electric motor, PMDC motors use permanent magnets to produce the stator field. Characteristics: used in commercial production of toys and appliances, cheaper to manufacture, good low-end torque, limited high-end torque.

Brushless Motors:

Motors in the brushless category do not have a commutator and brushes. Instead, the rotor is a permanent magnet and the coils are on the stator. Rather than controlling the magnetic fields on the rotor, brushless motors control the magnetic fields from the stator by adjusting the magnitude and direction of the current in the coils. One of the main advantages of brushless motors their its efficiency, which allows for greater control and production of torque in a more compact assembly.

AC Motors:

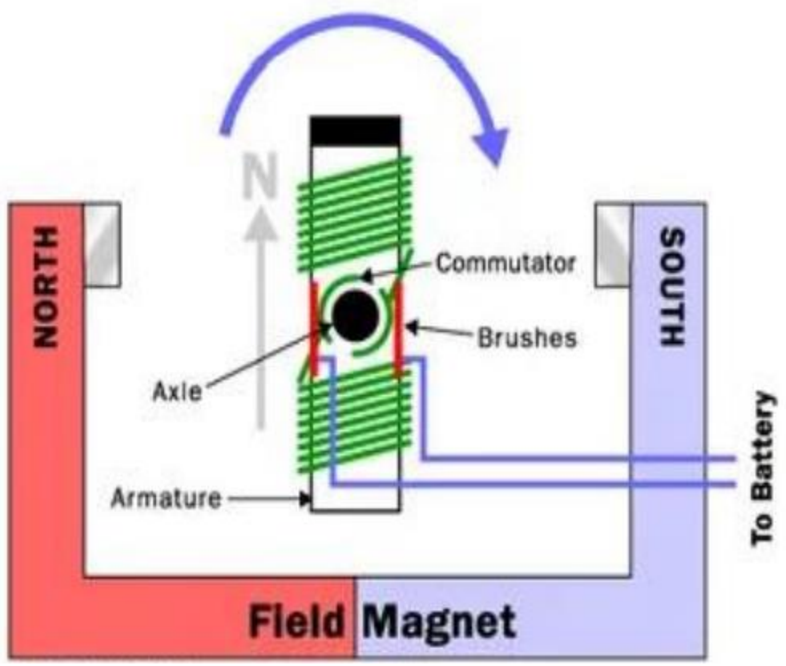
❖ Synchronous Motor:

A synchronous motor is a doubly excited machine, meaning it includes two electrical inputs. In a common three-phase synchronous motor, one input, usually three-phase AC, supplies the stator winding to produce a three-phase, rotating magnetic flux. The rotor supply is usually DC, which excites or starts the rotor. Once the rotor field locks with the stator field, the motor becomes synchronous.

❖ Asynchronous (Induction):

In contrast to synchronous motors, induction allows asynchronous to start by supplying power to the stator without supplying to the rotor. Induction motors have either a wound or a squirrel-cage design.

3.3 HOW IT WORKS:



<u>Fig 06: Inside of an Electric Motor</u>

Electrical energy is supplied to the stator via the car's battery. The coils within the stator (made from the conducting wire) are arranged on opposite sides of the stator core and act as magnets, in a way. Therefore, when the electrical energy from the car battery is supplied to the motor, the coils create rotating, magnetic fields that pull the conducting rods on the outside of the rotor along behind it. The spinning rotor is what creates the mechanical energy needed to turn the gears of the car, which, in turn, rotate the tires. Now in a typical car, i.e., non-electric, there is both an engine and an alternator. The battery powers the engine, which powers the gears and wheels. The rotation of the wheels is what then powers the alternator in the car and the alternator recharges the battery. This is why you are told to drive your car around for a period after being jumped: the battery needs to be recharged to function appropriately. There is no alternator in an electric car. So, how does the battery recharge then? While there is no separate alternator, the motor in an electric car acts as both motor and alternator.

This is due to the alternating nature of the AC signal that allows the voltage to be easily stepped up or stepped down to different values. That's one of the reasons why electric cars are so unique. As referenced above, the battery starts the motor, which supplies energy to the gears, which rotates the tires. This process happens when your foot is on the accelerator the rotor is pulled along by the rotating magnetic field, requiring more torque. But what happens when you let off the accelerator? When your foot comes off the accelerator the rotating magnetic field stops, and the rotor starts spinning faster (as opposed to being pulled along by the magnetic field). When the rotor spins faster than the rotating magnetic field in the stator, this action recharges the battery, acting as an alternator.

3.4 CONTROLLER:

Fig 07: Controller

A motor controller might include a manual or automatic means for starting and stopping the motor, selecting forward or reverse rotation, selecting and regulating the speed, regulating or limiting the torque, and protecting against overloads and electrical faults.

A motor controller is a device or group of devices that can coordinate in a predetermined manner the performance of an electric motor. A motor controller might include a manual or automatic means for starting and stopping the motor, selecting forward or reverse rotation, selecting and regulating the speed, regulating or limiting the torque, and protecting against overloads and electrical faults. Motor controllers may use electromechanical switching or may use power electronics devices to regulate the speed and direction of a motor.

3.5TYPES OF CONTROLLERS:

Motor controllers can be manually, remotely, or automatically operated. They may include only the means for starting and stopping the motor or they may include other functions.

An electric motor controller can be classified by the type of motor it is to drive, such as permanent magnet, servo, series, separately excited, and alternating current.

A motor controller is connected to a power source, such as a battery pack or power supply, and control circuitry in the form of analog or digital input signals.

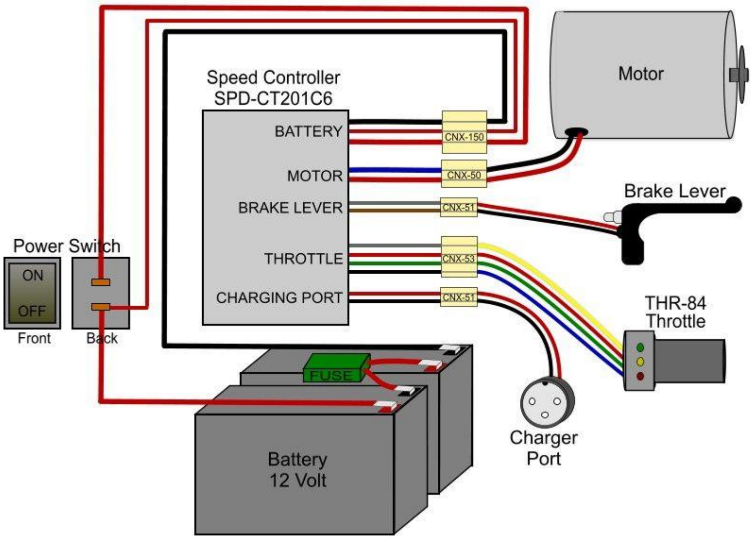


Fig 08: Wiring Diagram

There are four basic motor controller and drive types,

Types:

AC, DC, servo, and stepper, each having an input power type modified to the desired output function to match with an application.

3.6 APPLICATIONS OF CONTROLLER:

- Motor controllers are used with both direct current and alternating current motors. A controller includes the means to connect the motor to the electrical power supply, and may also include overload protection for the motor, and over-current protection for the motor and wiring.
- A motor controller may also supervise the motor's field circuit, or detect conditions such as low supply voltage, incorrect polarity or incorrect phase sequence, or high motor temperature. Some motor controllers limit the inrush starting current, allowing the motor to accelerate itself and connected mechanical load more slowly than a direct connection.

- Motor controllers may be manual, requiring an operator to sequence a starting switch through steps to accelerate the load, or may be fully automatic, using internal timers or current sensors to accelerate the motor.
- Some types of motor controllers also allow adjustment of the speed of the electric motor. For direct-current motors, the controller may adjust the voltage applied to the motor or adjust the current flowing in the motor's field winding.
- Alternating current motors may have little or no speed response to adjusting terminal voltage, so controllers for alternating current instead adjust rotor circuit resistance (for wound rotor motors) or change the frequency of the AC applied to the motor for speed control using power electronic devices or electromechanical frequency changers.

Chapter – 4

BATTERIES

4.1 INTRODUCTION:

Batteries are a collection of one or more cells whose chemical reactions create a flow of electrons in a circuit. All batteries are made up of three basic components: an anode (the '-' side), a cathode (the '+' side), and electrolyte (a substance that chemically reacts with the anode and cathode).

A battery is a device capable of converting the chemical energy, contained in the active materials that compose it into electric energy by electrochemical red ox reactions. Although 'battery' is the term generally adopted to refer to them, the basic electrochemical unit is denominated 'cell'.

When the anode and cathode of a battery are connected to a circuit, a chemical reaction takes place between the anode and the electrolyte. This reaction causes electrons to flow through the circuit and back into the cathode where another chemical reaction takes place. When the material in the cathode or anode is consumed or no longer able to be used in the reaction, the battery is unable to produce electricity. At that point, your battery is "dead."

Fig 09: Electric Battery

An automotive battery or car battery is a rechargeable battery that is used to start a motor vehicle. Its main purpose is to provide an electric current to the electric-powered starting motor, which in turn starts the chemically powered internal combustion engine that propels the vehicle.

4.2 HISTORY:

Early cars did not have batteries, as their electrical systems were limited. A bell was used instead of an electric horn, headlights were gas-powered, and the engine was started with a crank. Car batteries became widely used around 1920 as cars became equipped with electric starter motors. The sealed battery, which did not require refilling, was invented in 1971.

The first starting and charging systems were designed to be 6-volt and positive ground systems, with the vehicle's chassis directly connected to the positive battery terminal. Today, almost all road vehicles have a negative ground system. The negative battery terminal is connected to the car's chassis.

The Hudson Motor Car Company was the first to use a standardized battery in 1918 when they started using Battery Council International batteries. BCI is the organization that sets the dimensional standards for batteries.

Cars used 6 V electrical systems and batteries until the mid-1950s. The changeover from 6 to 12 V happened when bigger engines with higher compression ratios required more electrical power to start. Smaller cars, which required less power to start, stayed with 6 V longer, for example, the Volkswagen Beetle in the mid-1960s and the Citroën 2CV in 1970.

In the 1990s a 42V electrical system standard was proposed. It was intended to allow more powerful electrically driven accessories, and lighter automobile wiring harnesses. The availability of higher-efficiency motors, new wiring techniques, and digital controls, and a focus on hybrid vehicle systems that use high-voltage starter/generators have largely eliminated the push for switching the main automotive voltages.

4.3TYPES OF BATTERIES:

Batteries that must be thrown away after use are known as primary batteries. Batteries that can be recharged are called secondary batteries.

- Primary Batteries
- Secondary Batteries

4.3.1 Primary Battery (or) Secondary cell:

Primary cells are those cells in which the chemical reaction occurs only once, and the cell becomes dead after some time and it cannot be used again. These batteries are used as source of dc power. They can be used as long as the active materials are present.

Eg: Dry cell (Leclanche Cell) and Mercury cell, lithium cell.

Requirements of Primary cell:

It should satisfy these requirements

1. It must be convenient to use.
2. Cost of discharge should be low.
3. Stand-by power is desirable.

4.3.2 Secondary Battery (or) Secondary cell:

These cells can be recharged by passing an electric current through them and can be used again and again. Uses: In electronic equipment, automobile equipment, digital cameras, laptops, flashlight.

Eg: Lead storage battery, Nickel-Cadmium battery, or Lithium-ion cell battery.

4.4 TYPES OF BATTERIES USED IN ELECTRICAL VEHICLES:

Mainly the following types of batteries are used for electrical vehicles, namely

1) Lead Acid Batteries and Nickel Metal Hydride Batteries
2) Lithium Ion Batteries

4.4.1 Lead Acid Batteries and Nickel Metal Hydride Batteries:

Both lead acid batteries and nickel metal hydride (NiMH) batteries are mature battery technologies. These types of batteries were originally used in early electric vehicles such as General Motor's EV1. However, they are now considered to be obsolete with regard to their uses as the main source of energy storage in BEVs. Lead-acid batteries have seen used in conventional petroleum-driven vehicles and are relatively inexpensive. However, this type of battery has poor specific energy (34 Wh/kg). NiMH batteries are superior, as they can have up to double the specific energy (68 Wh/kg) compared with lead acid batteries. This allows electric vehicles that utilize NiMH batteries to be significantly lighter, leading to reduced energy cost for propelling the BEVs. Similarly, NiMH batteries also have greater energy density compared to lead-acid batteries, which will allow the battery system to be contained within a smaller space. Though, NiMH batteries do have some drawbacks, such as having lower charging efficiencies than the other batteries. There is also a major issue with self-discharge (up to 12.5% per day under normal room temperature conditions) that is exacerbated when the batteries are in a high-temperature environment. This makes NiMH batteries less ideal for hotter environments. Furthermore, there has been legal controversy regarding large-format NiMH batteries, which has affected the use of NiMH batteries in battery electric vehicles.

4.4.2 Lithium-Ion Batteries

Lithium-ion (Li-ion) batteries are now considered to be the standard for modern battery electric vehicles. There are many types of Li-ion batteries that each have different characteristics, but vehicle manufacturers are focused on variants that have excellent longevity. Compared to other mature battery technologies, Li-ion offers many benefits. For example, it has excellent specific energy (140 Wh/kg) and energy density, making it ideal for battery electric vehicles. Li-ion batteries are also excellent in retaining energy, with a self-discharge rate (5% per month) that an order of magnitude lower than NiMH batteries. However, Li-ion batteries also have some drawbacks as well. Comparatively, Li-ion batteries have been a very expensive battery technology. There are also major safety concerns regarding the overcharging and overheating of these batteries. Li-ion can experience a thermal runaway, which can trigger vehicle fires or explosions. There had been several instances where the Tesla Model S, which utilized Li-ion batteries, had infamously caught on fire due to issues with fluctuating charging or damage to the battery. However, great efforts have been made to help improve the safety of vehicles that use Li-ion batteries.

4.5 BATTERY APPLICATIONS:

The table below shows the range of applications which use batteries together with typical battery capacities required by the application. The section on Battery Types outlines the diverse range of batteries which are available for powering these applications.

TYPE	ENERGY	APPLICATIONS

Miniature Batteries	100 mWh-2 Wh	Electric watches, calculators, implanted medical devices (Mostly Primary Cells in small Button Cell packages)
Batteries for Portable Equipment	2 Wh-100 Wh	Flashlights, toys, power tools, portable radio and TV, mobile phones, camcorders, lap-top computers, memory refreshing, instruments, cordless devices, wireless peripherals, emergency beacons (Mostly Secondary Cells such as NiCad, NiMH and Lithium Ion as well as some Alkaline primary cells)
SLI Batteries (Starting Lighting& Ignition)	100-600 Wh	Cars, trucks, buses, lawn mowers, wheelchairs, robots (Mostly Lead Acid batteries)
Vehicle Traction Batteries	20 -630 kWh	EVs, HEVs, PHEVs, forklift trucks, milk floats, locomotives (NiMH and Lithium)
Stationary Batteries	250 Wh-5 MWh	Emergency power, local energy storage, remote relay stations, communication base stations, uninterruptible power supplies (UPS). (Mostly Lead Acid with Lithium recently making some inroads)
Military & Aerospace	Wide range	Satellites, munitions, robots, emergency power, communications (Fuel Cells, Nickel Hydrogen, Water Activated batteries, and other Alternatives)

Special Purpose	3MWh	Submarines (Mostly Lead Acid batteries)
Load Levelling Batteries	5-100 MWh	Spinning reserve, peak shaving, load-leveling (Various Lead Acid and Lithium plus Alternatives)

4.6 BATTERY SAFETY TIPS:

- Follow these safety principles when using batteries.
- Always follow warnings and manufacturer's instructions for both the batteries and the battery-operated product. Use only the correct type and size battery indicated.
- Check the contacts of both the battery and the battery-operated product for cleanliness.
- Always insert the batteries correctly with regard to polarity (-/+), matching the positive and negative symbols of both battery and product. Putting them in backwards, the product will sometimes still operate, but may inadvertently charge the batteries resulting in venting or leaking.
- Remove and safely dispose of exhausted batteries immediately.
- Replace all batteries in battery-operated products at the same time and with the batteries of the same type and manufacture.
- Do not short circuit batteries. When the positive (+) and negative (-) terminals of a battery are in contact with each other, the battery can become short circuited. For example, loose batteries in a pocket with keys or coins can be short circuited possibly resulting in venting or explosion.
- Do not heat batteries.
- Do not crush, puncture, dismantle or otherwise damage batteries.
- Do not charge non-rechargeable batteries.
- Keep batteries out of reach of small children.

CHAPTER -5

BRAKES

5.1 INTRODUCTION:

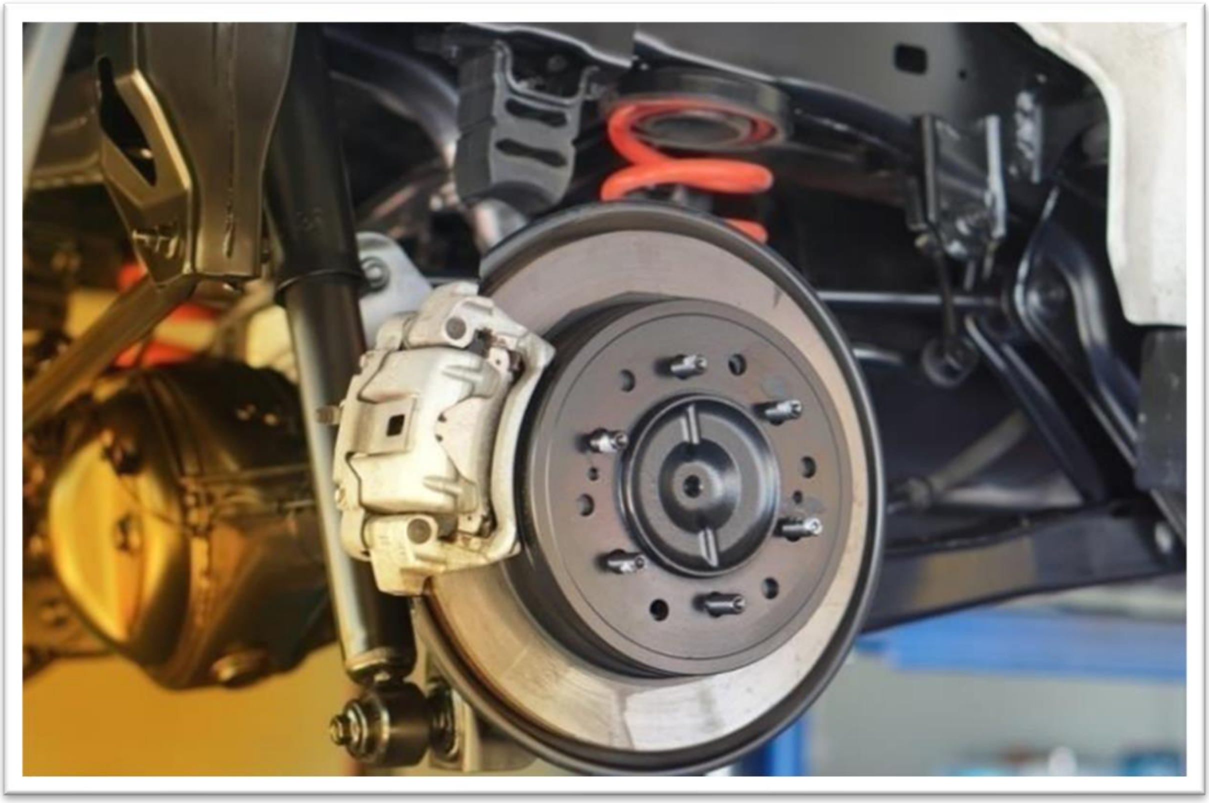


Fig 10: Brakes

A brake is a mechanical device that inhibits motion by absorbing energy from a moving system. It is used for slowing or stopping a moving vehicle, wheel, axle, or to prevent its motion, most often accomplished by means of friction.

Most brakes commonly use friction between two surfaces pressed together to convert the kinetic energy of the moving object into heat, though other methods of energy conversion may be employed. For example, regenerative braking converts much of the energy to electrical energy, which may be stored for later use. Other methods convert kinetic energy into potential energy in such stored forms as pressurized air or pressurized oil. Eddy current brakes use magnetic fields to convert kinetic energy into electric current in the brake disc, fin, or rail, which is converted into heat. Still other braking methods even transform kinetic energy into different forms, for example by transferring the energy to a rotating flywheel.

Brakes are generally applied to rotating axles or wheels but may also take other forms such as the surface of a moving fluid (flaps deployed into water or air). Some vehicles use a combination of braking mechanisms, such as drag racing cars with both wheel brakes and a parachute, or airplanes with both wheel brakes and drag flaps raised into the air during landing.

Since kinetic energy increases quadratically with velocity (K = mv2/2) an object moving at 10 m/s has 100 times as much energy as one of the same mass moving at 1 m/s, and consequently the theoretical braking distance, when braking at the traction limit, is up to 100 times as long. In practice, fast vehicles usually have significant air drag, and energy lost to air drag rises quickly with speed.

Friction brakes on automobiles store braking heat in the drum brake or disc brake while braking then conduct it to the air gradually. When travelling downhill some vehicles can use their engines to brake.

5.2 CHARACTERISTICS OF BRAKES:

- Peak Force
- Continuous power dissipation
- Fade
- Smoothness
- Power
- Pedal feel
- Drag
- Durability
- Weight
- Noise

1. **Peak force:** The peak force is the maximum decelerating effect that can be obtained. The peak force is often greater than the traction limit of the tires, in which case the brake can cause a wheel skid.
2. **Continuous power dissipation:** Brakes typically get hot in use and fail when the temperature gets too high. The greatest amount of power (energy per unit time) that can be dissipated through the brake without failure is the continuous power dissipation. Continuous power dissipation often depends on e.g., the temperature and speed of ambient cooling air.
3. **Fade:** As a brake heats, it may become less effective, called brake fade. Some designs are inherently prone to fade, while other designs are relatively immune. Further, use considerations, such as cooling, often have a big effect on the fade.
4. **Smoothness:** A brake that is grabby, pulses, has chatter, or otherwise exerts varying brake force may lead to skids. For example, railroad wheels have little traction, and friction brakes without

an anti-skid mechanism often lead to skids, which increases maintenance costs and leads to a "thump" feeling for riders inside.

5. **Power:** Brakes are often described as "powerful" when a small human application force leads to a braking force that is higher than typical for other brakes in the same class. This notion of "powerful" does not relate to continuous power dissipation and may be confusing in that a brake may be "powerful" and brake strongly with a gentle brake application yet have lower (worse) peak force than a less "powerful" brake.
6. **Pedal feel**: Brake pedal feel encompasses subjective perception of brake power output as a function of pedal travel. Pedal travel is influenced by the fluid displacement of the brake and other factors.
7. **Drag:** Brakes have a varied amount of drag in the off-brake condition depending on design of the system to accommodate total system compliance and deformation that exists under braking with the ability to retract friction material from the rubbing surface in the off-brake condition.
8. **Durability:** Friction brakes must wear surfaces that must be renewed periodically. Wear surfaces include the brake shoes or pads, and the brake disc or drum. There may be trade-offs, for example, a wear surface that generates high peak force may also wear quickly.
9. **Weight:** Brakes are often "added weight" in that they serve no other function. Further, brakes are often mounted on wheels, and unsprang weight can significantly hurt traction in some circumstances. "Weight" may mean the brake itself or may include additional support structure.
10. **Noise:** Brakes usually create some minor noise when applied, but often create squeal or grinding noises that are quite loud.

5.3 BRAKING SYSTEM:

Brake is a mechanical device. From a moving system, it absorbs energy and inhibits motion. It is used for reducing the speed of a wheel or axle. It works by means of friction. The maximum decelerating effect obtained is called peak force, which is the main characteristic of the braking system. The temperature of brakes gets high when they are typically used, and this may lead to the failure of the system.

5.4 TYPES OF BRAKING SYSTEMS:

There are three types of braking systems which include the following.

1. **Mechanical Braking System**
    - ❖ Drum braking
    - ❖ Disc braking

- ❖ Band braking
- ❖ Pawl and Ratchet braking

2. Electrical braking system

- ❖ Plugging type braking
- ❖ DC injection type braking
- ❖ Eddy current braking
- ❖ Dynamic resistor type braking
- ❖ Regenerative braking
- ❖ Sharing DC bus type braking

3. Other Types of Braking Systems

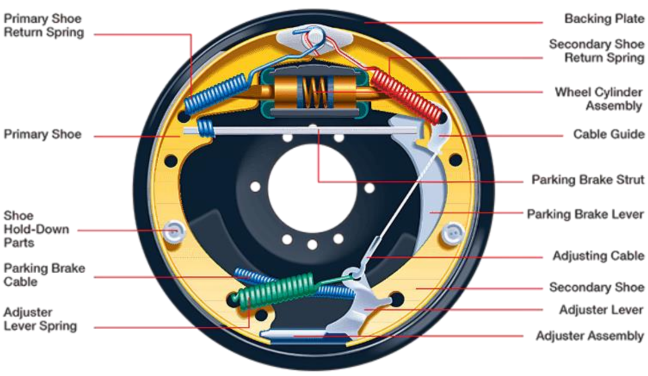
- ❖ Hydraulic braking system
- ❖ Power brakes
- ❖ Air braking system
- ❖ Air hydraulic braking system
- ❖ Vacuum brakes/ servo braking system

1. Mechanical braking system:

Mechanical braking system mostly used in scooters, motor vehicles, and motorcycles where small power is required. It is essential in manufacturing power transmission applications, material handling, etc. It delivers forces to the axle or a wheel in order to stop motion. It helps to reduce the speed of the system slowly by the mechanical process when compared to electrical braking.

The working of a mechanical brake depends on the pedal. When the pedal is pressed, the brake shoes are pushed outwards and rotate against the drum which is connected to the wheels. Hence the machine or vehicle gets slow down and stopped. And when the pedal is released, it goes to normal position due to the pullback action of spring shoes.

Drum Brakes Are Type of Mechanical Brake



Construction and working of a drum brake system:

The details of the drum brake system can be seen in the picture. The brake shoes which are roughly semi-circular are made to contact the inside surface of the brake drum. In most designs, two shoes are used with each drum to form a complete brake mechanism at each wheel. The brake shoes have brake linings on their outer surfaces. Each brake shoe is hinged at one end by an anchor pin. The anchor pin is fixed to the backing plate. The other end of each shoe rests on a cam. This can be turned by the camshaft which passes through a hole in the backing plate. The camshaft can be operated by the brake pedal through suitable linkages.

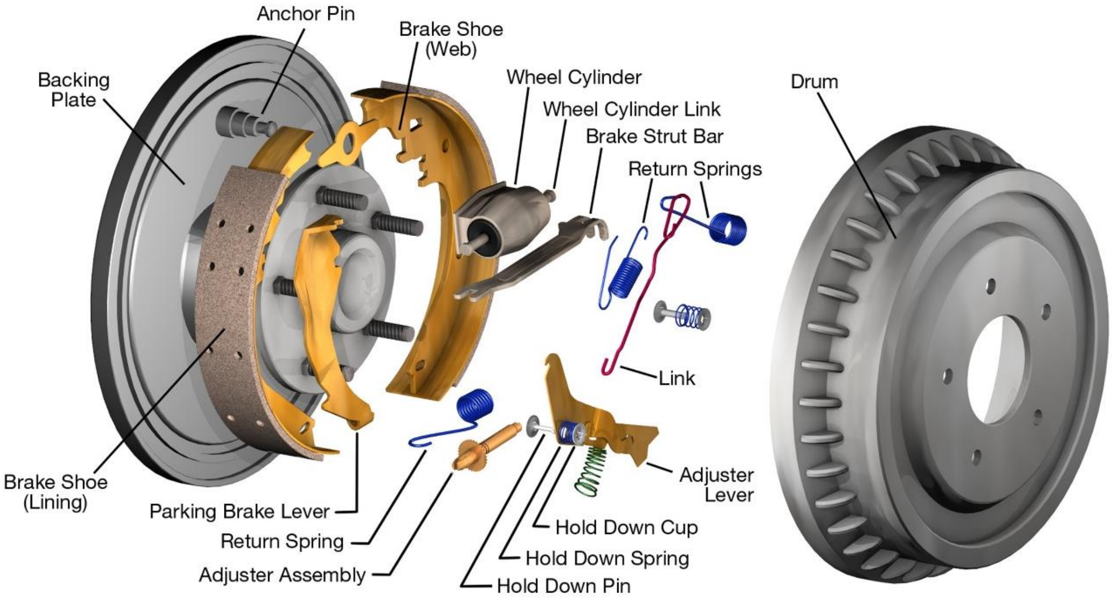


Fig 12: Construction of Drum Brake

When the cam is turned, the brake shoes expand outward; the brake linings come into contact with the brake drum. Brake lining increases the coefficient of friction and also prevents the wearing away of the metal. The force of friction is opposite to the direction of drum rotation. The friction between the drum surface and the shoe linings serves to stop or slow down the drum rotation and hence the wheel rotation.

Working of a drum brake

The friction force that comes into action also tends to make the shoes to revolve with the drum. The latter action is prevented by the pin and the cam. The pin is therefore called the anchorage pin.

The friction force that comes into action also tends to make the shoes to revolve with the drum. The latter action is prevented by the pin and the cam. The pin is therefore called the anchorage pin

Internal expanding shoe brakes are the generally used braking system in automobiles. In an automobile, the wheel is fitted on a wheel drum. The brake shoes are fitted in contact with inner surface of this drum to apply brakes.

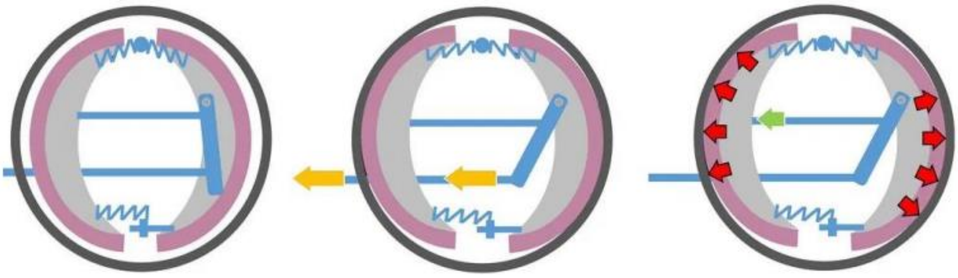


Fig 13: Working of Drum Brake

The retracting spring is held between the brake shoes. These retracting springs draw the shoes away from the drum when the cam is turned and moved to the release position. This system in which the shoes are mounted to rub against the inside surface of the brake drum is called an internal expanding brake. In this system, each part of the linkage must be free to move. The joints must be properly lubricated to reduce friction and wear. Otherwise erratic and unequal braking action may result.

Construction and Working of Disc Brakes in an Automobile

The construction of the mechanical disc brake is shown in the picture. The whole assembly contains a pair of brake shoes with brake linings, two anchor pins and retractor spring, a cam and a brake drum. Brake linings are attached on outer surface of each brake shoe.

Fig 14: Components of a disc brake

The brake shoes are hinged at one end by means of anchor pins. The last end of the brake shoe is functioned by a cam to expand it counter direction to the brake drum. Retracting springs provided are used for bringing the shoes to their original position when brakes are not applied. The brake drum closes inside it the entire mechanism to protect it from dust and sand. A plate holds the total assembly and fits car axle. It also acts as a base to fasten the brake shoes and another operating mechanism.

How Brakes are Applied and Released

When the brake pedal is pressed, the cam turns through brake linkages. Brake shoes expand towards brake drum due to turning of cam. The brake linings rub against brake drum and therefore motion of wheels is stopped. The pedal force is transmitted to the brake shoes through a mechanical linage. This device also multiplies the force to apply the brakes effectively. When force on brake pedal is removed, the retractor spring brings the shoes back to original position and brakes are released.

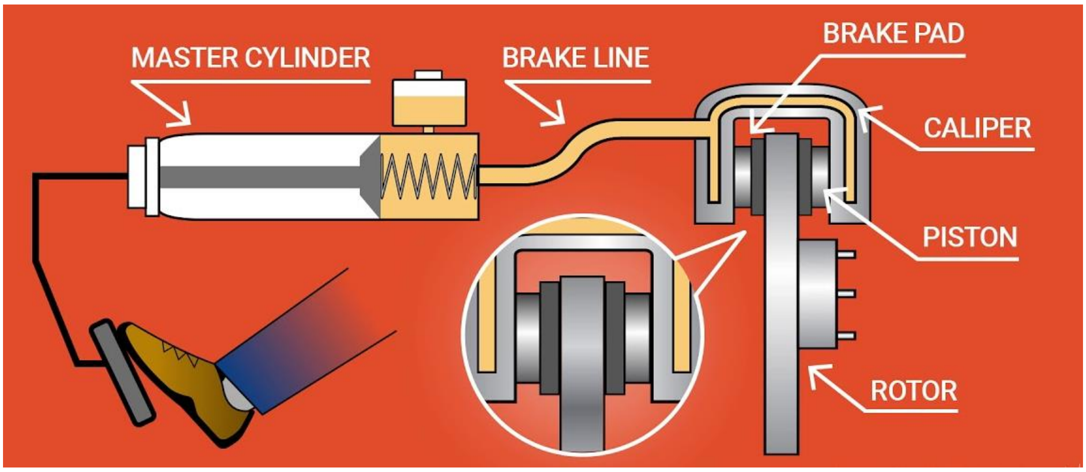


Fig 15: Working of a Disc Brake

2. Electrical Braking System:

Electrical braking is used to reduce the speed of the machine depending on flux and torque. This type of braking is mainly used for functional braking to control the speed of the machine. It is easy to handle and comfortable. But it cannot be used for emergency braking and parking braking. The working of electrical braking depends on the electromagnetic force (EMF) acting on the brake shoes. The battery is used to generate an electric current which helps to energize the electromagnet mounted on the backplate. This results in activating the cam and expanding the brake shoes. Hence the vehicle or machine is stopped by breaking the wheel.

2.1 Regenerative Braking:

It is one of the types of electrical braking system. When the speed of the motor is increased than the synchronous speed, then the regenerative braking is used. When the rotor rotates higher than the speed of the synchronous speed, then the motor acts as a generator and the directions of current flow and the torque are reversed. Hence the generator is stopped by braking. The main disadvantage is, when the motor exceeds the synchronous speed, it is possible of mechanical and electrical damage. So, regenerative braking can be done at the sub-synchronous speed only when the variable frequency source is applied.

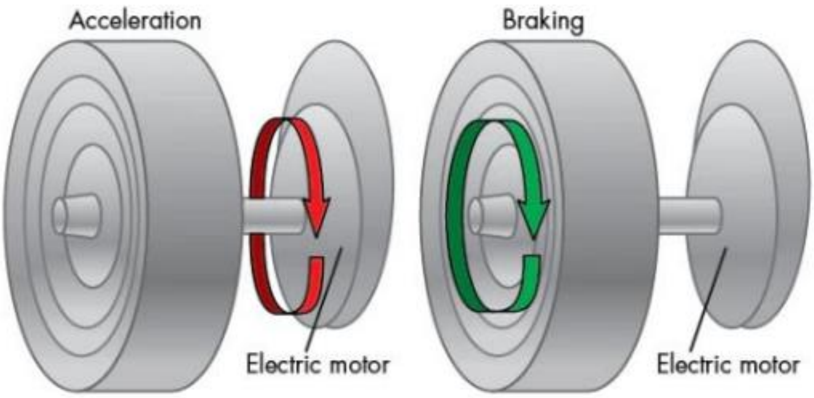


Fig 16: Regenerative braking system

An inverter is used to return excess energy back to the three-phase supply rather than the dissipation of energy in the resistor. To drive the variable frequency systems, an inverter is connected in parallel to the rectifier. The regenerative braking is mainly used in electric vehicles.

2.2 Plugging type Braking:

It is also one of the types of electro braking system. In this type, the pedal is used for braking the vehicle. When the pedal is pressed, the speed of the electric vehicle is reduced by changing the polarity and direction of the motor. The direction of the motor gets reversed and in turn causes breaking the wheel. In generators, the use of the plugging type braking system results in decreased speed due to the reversal of terminals of the supply, reversal of torque, and restriction of rotation of the motor. An external resistor is used to limit the current flowing through the plugging circuit. The more power is wasted during the plugging.

2.3 Dynamic Braking:

It is also known as dynamic resistor braking or dynamic rheostat braking. In this type, the resistance is provided to the motor by the rheostat connected to the circuit is capable of acceleration or deceleration of the vehicle. This resistance helps to reduce the speed and stops the electric vehicle.

The resistor or rheostat in the circuit dissipates excess energy on the capacitor by connecting a resistor in parallel with the capacitor.

When the motor acts as a generator, reverse current flows through the circuit, and the torque changes and causes braking. The resistance in the circuit can be removed to maintain the constant torque while breaking the motor

3. Other types of braking system:

3.1 Hydraulic Braking System:

Hydraulic braking system is a type of braking system in which unlike the mechanical braking system, hydraulic fluid is used to transmit the brake pedal or brake lever force from the brake pedal or brake lever to the final drum shoes or disc calliper in order to achieve braking.

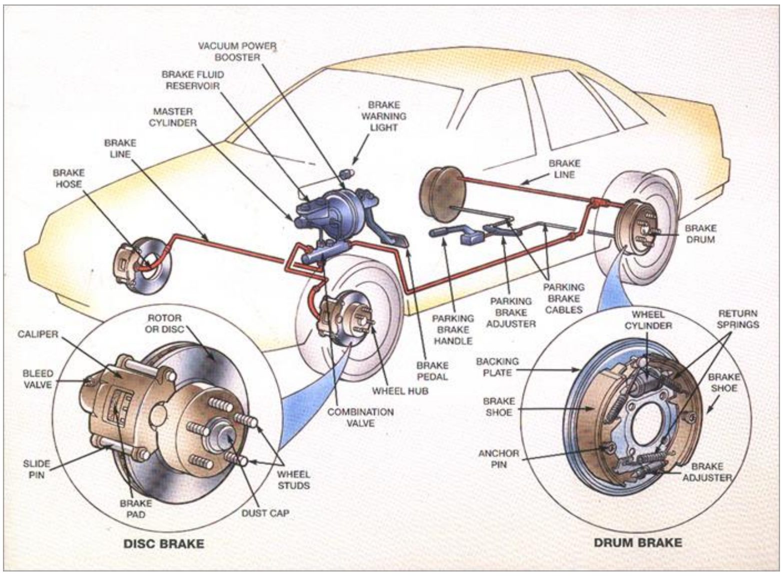


Fig 17: Schematic Diagram of Hydraulic Braking System

Hydraulic brakes work on the principle of Pascal's law. According to this law whenever pressure is applied on a fluid it travels uniformly in all the directions. Therefore, when we apply force on a small piston, pressure gets created which is transmitted through the fluid to a larger piston.

Pascal's law:

Pascal's principle, also called Pascal's law, in fluid (gas or liquid) mechanics, statement that, in a fluid at rest in a closed container, a pressure change in one part is transmitted without loss to every portion of the fluid and to the walls of the container. The principle was first enunciated by the French scientist Blaise Pascal. The pressure exerted anywhere in a mass of confined liquid is transmitted undiminished in all directions throughout the liquid

Fig 18: Blaise Pascal

Working of Hydraulic Braking System:

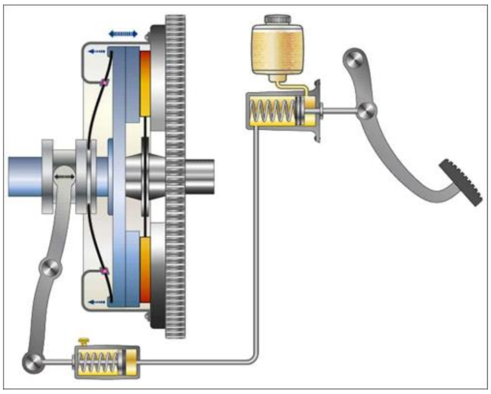


Fig 19: Hydraulic Braking System

When we press the brake pedal, it pushes on primary piston through a linkage. Pressure is built in the cylinder and the lines as the brake pedal is depressed further. The pressure between the primary and secondary piston forces the secondary piston to compress the fluid in its circuit. If the brakes are operating properly, the pressure will be same in both the circuits. If there is a leak in one of the circuits, that circuit will not be able to maintain pressure.

3.2 Air Braking System:

The Air-Brake system consists of a normal drum brake, but the difference is in the actuation mechanism. When the brakes pedal is pressed or the foot operated valve is pressed, the valve opens and air from the reservoir rushes into the brake chambers which actuates the drum brakes.

- Air Brakes (also known as pneumatic brakes/harsh brake) are predominantly used on medium and heavy-duty commercial vehicles having much higher braking torque requirements.
- Air brakes are more effective and are actuated faster with shorter braking distances
- This is the reason why heavy commercial vehicles are fitted with sign boards reading "Caution Air Brakes" near the taillights.

- The simplest system consists of an air compressor, compressor cut-out, pressure gauge, drain plug/safety valve and the reservoir constitute the compressing and control unit whereas the rest of them are termed as application units.
- Figure shows the layout an air-brake system.
- Air from the atmosphere is taken in and compressed in the compressor which is a centrifugal type driven by the engine.
- The compressed air from the compressor is stored in the reservoir.
- A cut-off valve is provided to control the pressure inside the reservoir and acts as a non-return valve.
- The oil filter and air drier as the name suggests filters and dries the air coming out of the compressor
- The reservoir is connected to the brake chambers via a foot operated valve (also known as brake valve).
- The brake chamber is connected to the actuation mechanism of the drum brakes.

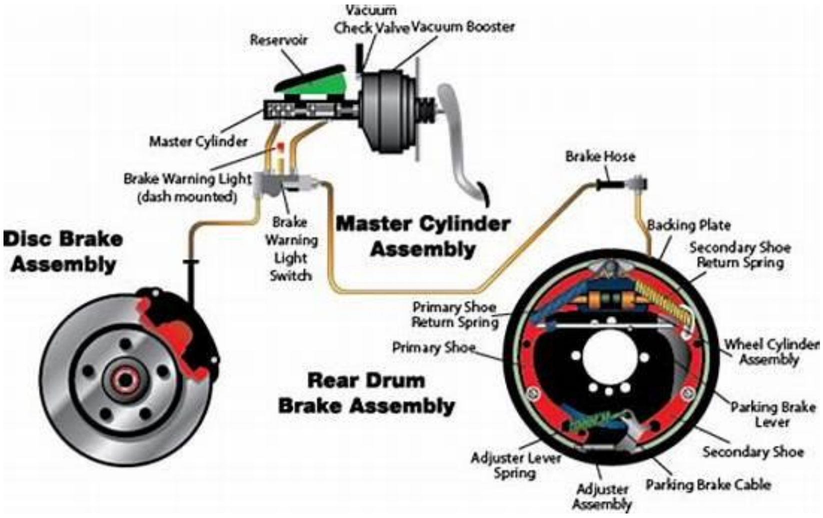


Fig 20: Components of an Air Braking System

Working:

- The Air-Brake system consists of a normal drum brake, but the difference is in the actuation mechanism.
- When the brakes pedal is pressed or the foot operated valve is pressed, the valve opens and air from the reservoir rushes into the brake chambers which actuates the drum brakes.
- As the pressure in the air reservoir decreases, the cut-off valve opens, and the air reservoir pressure is maintained.

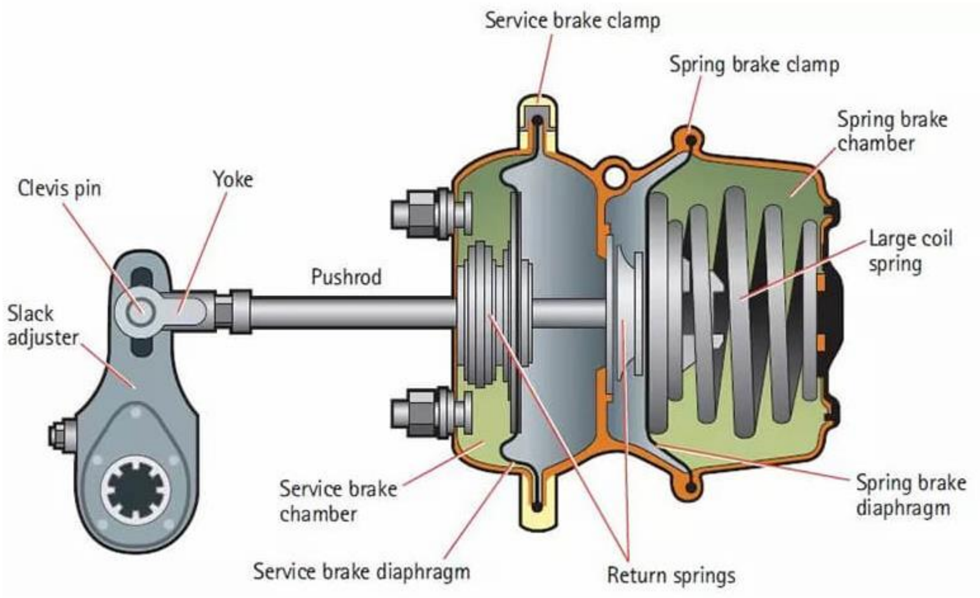


Fig 21: Working of an Air Braking System

When the brake pedal is pressed, the brake valve changes its position & brake valve opens. The compressed air from the brake valve from to brake chamber acts on the flexible diaphragms in the brake chamber. The diaphragm pushes the rods connected with the levers of the brake gear cam. The cam turns & expands the brake shoe to make frictional contact with the brake drum thus breaking the wheels. When the brake pedal has been released the supply of compressed air is cut off from the brake chamber & then we are connected to the atmosphere. The pressure from the chamber drops & brake shoes is returned to their initial position & wheel run free. The brake valve is equipped with servomechanism which ensures that the braking forces on the shoe proportion to the applied force on the pedal & also impart relative reaction to the movement of the pedal. So, the driver can senior the degree of brake application.

The unloader valve is located between compressor reservoir air pressure lines. The unloader valves are relieved the compressor of its pumping load once the uploader cut-out pressure is obtained & seal the reservoir. The compressor is built up a pressure depending upon the setting of the adjusting screw. The unloader then delivers the air discharged by the compressor to the atmosphere. Thus, allowing the compressor to run light while the reservoir contains enough supply of air. The air filter prevents the dust & foreign material entering the operating system. These are mounted on the chassis & have a drain plug to allow the condensate to be easily removed.

Chapter – 6

Wiring

6.1 Introduction:

Vehicle electrics is the system of electric wiring and parts in a vehicle. The vehicle electrics interconnect all the car electrical parts with each other by carrying electric current and voltage to all the parts such as various computers, sensors, actuators, motors, gauges, power windows, radio, headlights, sunroof, starter motor, and many other electrical components. All the electrical component receive voltage from the battery and returns it to the battery, through the car's metal body.

The battery is the fundamental source of power in the vehicle's electrical system that provides the electrical current to all electrical components when the engine is OFF. With the engine running, all the electrical components receive energy from the alternators. It is because the alternator produces a higher current than the battery, so at the same time, the alternator can charge the battery as well as supply current to all other needs of the car while the engine is running.

6.2 Wiring of Battery

In the initial stage of connecting batteries, we should be very careful while connecting in series. In this project we are using 6 Amaron Batteries (100ah 12V). Here we connected 5 batteries in series to get 60V output, and another battery for car EDM unit which controls the whole car wiring system like lightings, power windows, music system

Fig 22: Batteries Connected in Series

6.3 Connecting Batteries to The Controller:

After connecting batteries in series, we get one positive and one negative as output, these outputs are connected to the controller as show in the figure 23.

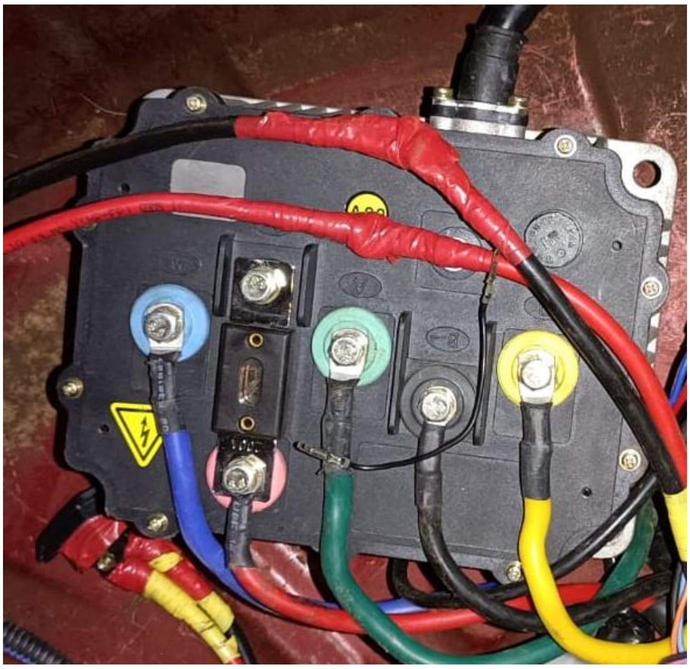


Fig 23: Controller with Wiring

6.4 Connecting Motor& Remaining connections with The Controller

After connecting battery and controller we need to give connections to the motor and the controller. Then after this we need to give some small and complicated connections like hall sensor, throttle, speed controller, forward & reverse switch, etc.

Fig 24: Connections of Controller

Fig 25: Motor Connected with Controller

CHAPTER-7

METHODOLOGY

Dissembling of engine

↓

Modification of braking system

↓

Removal of rear axle for fitting differential

↓

Blocking of Rear Brake High Pressure Break Fluid Pipes

↓

Connecting Batteries in Series

↓

Connecting Controller with Battery Terminals

↓

Connecting Motor & Controller

↓

Connecting Front & Reverse Gear with Controller

↓

Connecting Throttle with Controller

↓

Finally Connecting Key with the Controller

↓

Checking the Braking System

↓

Checking Connections give to the controller

Clean the wheel drum, brake oil filling and pumping

1. Removal of Rear Brake Drums:

At first, we removed rear brake drums which is connected to the body &braking system. After removal we blocked High Pressure brake fluid pipeline connections which are going for rear wheel brake drums.

After this step we checked the front wheel brake disks and break fluid pumping cylinder and replaced with a new one. Then filled the brake fluid (DOT3). After this step we checked the braking system and its perfectly working.

Fig 26: Brake Fluid Pump

2. Wiring

Initially we arranged 6 lead acid batteries of capacity 100ah & 12V, 5 batteries of them are connected in series to get 60V output and one is connected to the Car main EDM for lighting's, power windows, etc.

Fig 27: Batteries

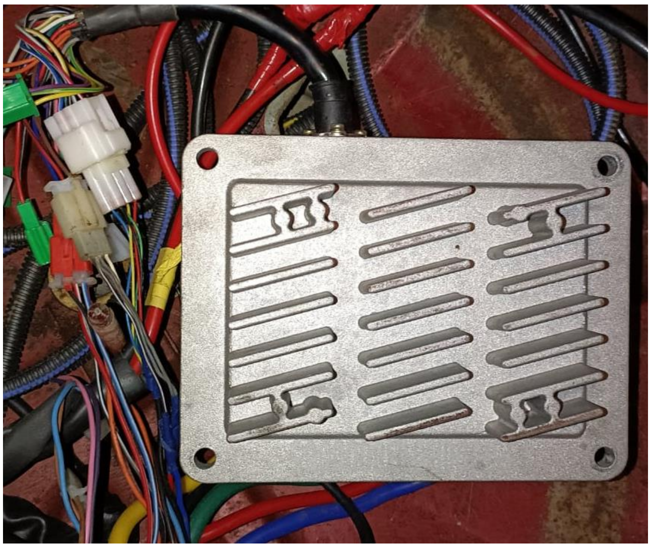


Fig 28: Controller

Now we have different coloured wires coming out from the controller, these are the connections for different parts of the car like key unit, throttle, gear unit, indicators, horns, head lamps, etc...

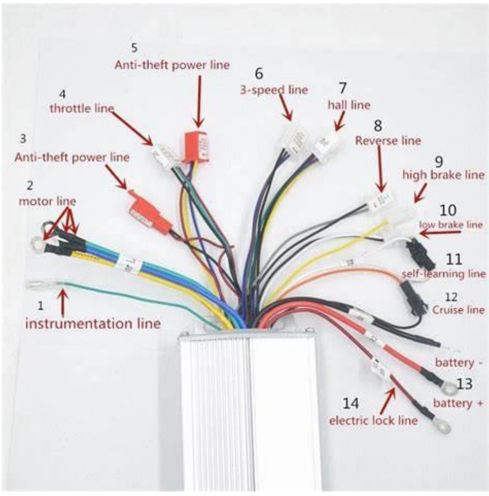


Fig 29: Controller with Different Coloured Wires

As we have seen in the figure 29 every induvial colour indicates connection to different parts as single red indicates to the battery positive and red pin indicates to the anti-theft power line , blue yellow & green coloured wires indicates to the motor connections, black blue and purple coloured wire attached to the white pin indicates to the 3 speed controller & green black and red wires set indicates to the throttle connection. And many more connections.

Fig 30: Foot Throttle

As said above remaining wires are connected to the respected parts of the like key, gear unit, 3 speed controller, speed meter etc…

Fig 31: Key

Chapter – 8

COST ANALYSIS

Sl. No	Particulars	Price
1.	Braking System Remodelling	Rs.4,000/-
2.	Wiring Kit	Rs.10,000/-
3.	Controller	Rs.20,000/-
4.	Throttle, Key,3 speed Controller, Gear lever	Rs.3,500/-
5.	Total cost	Rs.37,500/-

Chapter – 9

ADVANTAGES, DISADVANTAGES AND APPLICATIONS

ADVANTAGES:

- Compared to IC engines the electrical vehicles are easy to operate.
- Charging the E-vehicle is quite simple.
- Compared to IC engines, the maintenance cost is relatively less.
- It is completely pollution free and eco-friendly.
- It doesn't release any harmful gases.
- Maintenance is simple and easy to run the vehicle.
- No fossil fuels are used.
- No vibrations & no noise will be there.
- It is so better than gasoline vehicles.

DISADVANTAGES:

- These electric vehicles are runs with less speed.
- It requires more charge in order to function properly.
- Sometimes the battery may low and there is no other source to run the vehicle.
- More power consumes to run the vehicle.

APPLICATIONS:

The electrical vehicles are used to transport the goods from one place to another place. And used for travelling for domestic purpose.

Chapter – 10

RESULTS

- Transmission system is successfully remodelled as per requirement and is coupled with motor.
- Braking system is successfully remodelled and is fixed to the car with accurate efficacy.
- If the battery is full charged it gives the mileage up to 85 to 100km.
- The vehicle is runs starts with low speed and up to maximum 70kmph.
- The vehicle bares the load up to 8829N to 1.2 tonnes.
- The time taken to full charge is 3 hours.
- Easy to drive and control.

Fig 32: Final Remodelled Mahindra Logon Car

Chapter – 11

CONCLUSION

- Cost of fabrication is decreased when compared with diesel engine car.
- Running & maintenance of E-Vehicle is easy when compare to diesel engine cars
- After remodelling **MAHINDRA LOGON CAR,** the weight is decreased.
- No pollution is there, and it is eco-friendly.
- Achieved a mileage of 80kms per 3hours charging.
- It bears of load up to 1.2 tonnes.

Chapter – 12