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DESIGN AND CONFIGURATION OF AN ELECTRIC VEHICLE

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Abstract: *The aim of this report is to introduce the design and configuration of an electric vehicle. In this paper, working principle of an electric car and the automobile companies that manufacture electric cars and their models are described. From the history of electric cars in the world and the electric cars in today's generation, the design of an electric car in Solidworks, types of electric vehicle, advantages and disadvantages of electric vehicles is well described in this paper.*

Keywords: *Solidworks, Motors, Generator, Battery, Electric Vehicle Modelling.*

INTRODUCTION:

An electric car is an automobile that is propelled by one or more electric motors, using electrical energy stored in rechargeable batteries or another energy storage device. Electric motors give electric cars instant torque, creating strong and smooth acceleration. They are also around three times as efficient as cars with an internal combustion engine.

History of Electric Cars:

The fast-practical electric cars were produced in the 1880s. Electric cars were popular in the late 19th century and early 20th century, until advances in internal combustion engines, electric starters in particular, and mass production of cheaper gasoline vehicles led to a decline in the use of electric drive vehicles. The energy crises of the 1970s and 1980s brought a short-lived interest in electric cars; although, those cars did not reach the mass marketing stage, as is the case in the 21st century. By the end of the 19th century, with mass production of rechargeable batteries, electric vehicles became fairly widely used. Private cars, though rare, were quite likely to be electric, as were other vehicles such as taxis. An electric New York taxi from about 1901 is shown, with Lily Langtree alongside, in Figure 1.1. Indeed, if performance was required, the electric cars were preferred to their internal combustion or steam powered rivals. Figure 1.2 shows the first car to exceed the 'mile a minute' speed (60 mph) when the Belgium racing driver Camille Jenatzy, driving the electric vehicle known as 'La Jamais Contente',1 set a new land speed record of 106 kmph (65.7 mph). This also made it the first car to exceed 100 kmph.

Fig – 1: New York Taxi Cab in about 1901, a battery electric vehicle (The lady in the picture is Lillie Langtry, actress and mistress of King Edward VII.) (Photograph reproduced by permission of National Motor Museum Beaulieu.)

Types of Electric Vehicle:

In the 19th and 20th centuries development of ideas are now utilised to produce a new range of electric vehicles that are starting to make an impact. There are effectively six basic types of electric vehicle, which may be classed as follows. Firstly, there is the traditional battery electric vehicle, which is the type that usually springs to mind when people think of electric vehicles. However, the second type, the hybrid electric vehicle, which combines a battery and an IC engine, is very likely to become the most common type in the years ahead. Thirdly there are vehicles which use replaceable fuel as the source of energy using either fuel cells or metal air batteries. Fourthly there are vehicles supplied by power lines. Fifthly there are electric vehicles which use energy directly from solar radiation. Sixthly there are vehicles that store energy by alternative means such as flywheels or super capacitors, which are nearly always hybrids using some other source of power as well.

A. Battery Electric vehicles (BEV):

A battery electric vehicle (BEV) runs entirely using an electric motor and battery, without the support of a traditional internal combustion engine, and must be plugged into an external source of electricity to recharge its battery. Like all electric vehicles, BEVs can also recharge their batteries through a process known as regenerative braking, which uses the vehicle's electric motor to assist in slowing the vehicle, and to recover some of the energy normally converted to heat by the brakes.

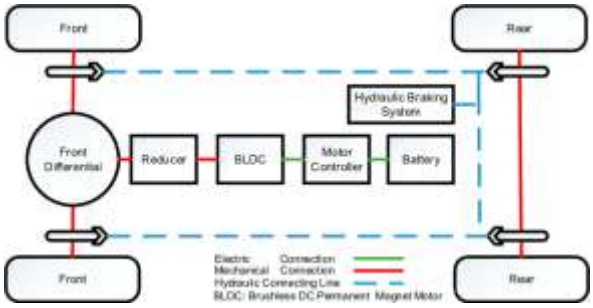

Fig – 2: Concept of BEV

Pros:

- No emissions
- No gas or oil changes
- Ability to conveniently charge at home
- Fast and smooth acceleration
- Low cost of operation - about $30 a month.

Cons:

- Shorter range than gasoline vehicles although most people drive well within the range of today's BEV and could rent a hybrid for the rare long trips.
- Slightly more expensive than their gasoline equivalent although the gasoline savings pay off the difference in typically 2-3 years.

The following table shows the current Battery Electric Vehicles (BEV) available today.

Table – 1: List of BEVs

VEHICLE MODEL	MODEL NAME	RANGE	PRICE	CHARGE TIME
	Tesla Model S	335-426km	$82,820 - $120,000	5 hours
	Nissan Leaf	120km	$31,798	3 hours
	BMW i3	160km	$44,950	6 hours
	Mitsubishi iMiEV	100km	$27,998	7 hours
	Smart EV	109km	$26,990	6 hours
	Ford Focus EV	110km	$36,199	4 hours

B. Hybrid Electric Vehicles:

A hybrid electric vehicle (HEV) is type of hybrid vehicle that combines a conventional internal combustion engine system with an electric propulsion system.

There are two basic arrangements for hybrid vehicles, the series hybrid and the parallel hybrid. In the series hybrid the vehicle is driven by one or more electric motors supplied either from the battery, or from the IC engine driven generator unit. In the parallel hybrid the vehicle can either be driven by the IC engine working directly through a transmission system to the wheels, or by one or more electric motors, or by both the electric motor and the IC engine at once.

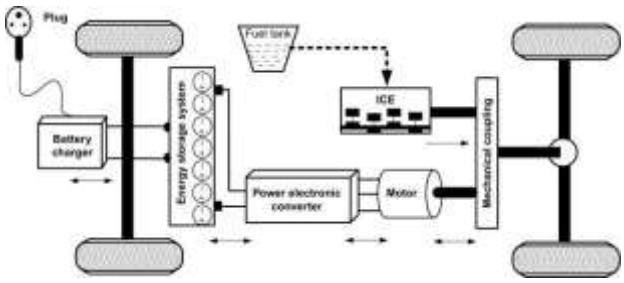

Fig – 3: Concept of EHV

Pros:

- Longer range than BEV
- Less gas consumption than gas only vehicle
- Fewer emissions than gas only vehicle

Cons:

- Still produces emissions
- Complex mechanics – Gasoline + Electric
- Expensive to operate (8-10 times more expensive than BEV) but less than traditional gasoline vehicle.
- No ability to conveniently charge at home.

The following table shows the current Hybrid Electric Vehicles (HEV) available.

Table – 2: List of HEVs

VEHICLE MODEL	MODEL NAME	PRICE	CHARGE TIME
	Audi Q5 Hybrid	$57,000	N/A
	Acura ILX Hybrid	$35,290	N/A
	Cadillac Escalade Hybrid	$75,000	N/A
	BMW Active Hybrid 3	$58,300	N/A
	BMW Active Hybrid 5	$71,150	N/A
	BMW Active Hybrid 7	$133,400	N/A
	Honda Civic Hybrid	$27,045	N/A
	Honda CR-Z Hybrid	$22,755	N/A
	Hyundai Sonata Hybrid	$28,249	N/A
	Infiniti Q50 Hybrid	$47,000	N/A
	Infiniti Q70 Hybrid	$68,500	N/A
	Infiniti QX60 Hybrid	$54,500	N/A
	Infiniti M Hybrid	$68,500	N/A
	Kia Optima Hybrid	$31,580	N/A
	Lexus CT 200h	$30,950	N/A
	Lexus RX 450h	$42,580	N/A
	Lexus ES 300h	$44,100	N/A
	Lexus GS 450h	$64,900	N/A
	Lexus LS 600h L	$125,000	N/A
	Lincoln MKZ	$37,960	N/A
	Toyota Highlander Hybrid	$47,300	N/A
	Toyota Camry Hybrid	$27,760	N/A
	Toyota Prius	C$26,105	N/A
	Toyota Prius C	C$20,440	N/A
	Toyota Prius V	C$26,750	N/A
	VW Jetta Turbo Hybrid	C$28,490	N/A

C. Fuelled Electric Vehicles

A fuel vehicle that runs on a fuel other than traditional petroleum fuels and also refers to any technology

of powering an engine that does not involve solely petroleum. Because of a combination of factors, such as environmental concerns, high oil prices and the potential for peck oil. Fuel cells in vehicles generate electricity to power the motor, generally using oxygen from the air and compressed hydrogen. Most fuel cell vehicles are classified as zero-emissions vehicles that emit only water and heat.

Most of the major motor companies have developed very advanced fuel cell powered cars. Daimler Chrysler for example have developed fuel cell cars based on the Mercedes A series, fitted with Ballard fuel cells. This fuel cell runs on hydrogen which is stored in liquid form.

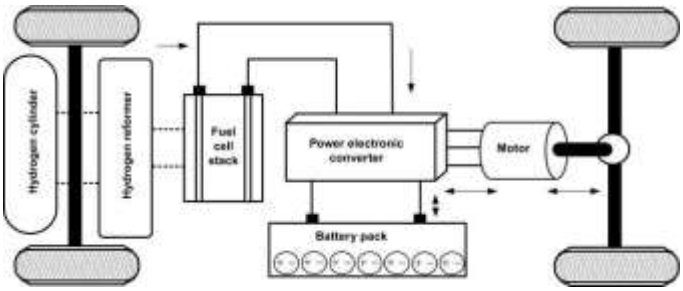

Fig – 4: Concept of FEV

D. Electric Vehicles Using Supply Lines:

Both the trolley bus and the tram are well known, and at one time were widely used as a means of city transport. They are a cost effective, zero emission form of city transport that is still used in some cities. Normally electricity is supplied by overhead supply lines and a small battery is used on the trolley bus to allow it a limited range without using the supply lines.

It is now difficult to see why most of these have been withdrawn from service. It must be remembered that at the time when it became fashionable to remove trams and trolley buses from service, cost was a more important criterion than environmental considerations and worries about greenhouse gases. Fossil fuel was cheap and overhead wires were considered unsightly, inflexible, expensive and a maintenance burden. Trams in particular were considered to impede the progress of the all-important private motor car. Today, when IC engine vehicles are clogging up and polluting towns and cities, the criteria have changed again. Electric vehicles powered by supply lines could make a useful impact on modern transport and the concept should not be overlooked by designers, although most of this book is devoted to autonomous vehicles.

E. Solar Powered Vehicles:

Solar powered vehicles such as the Honda Dream, which won the 1996 world solar challenge, are expensive and only work effectively in areas of high sunshine. The Honda Dream Solar car achieved average speeds across Australia, from Darwin to Adelaide, of 85 kph (50 mph). Although it is unlikely that a car of this nature would be a practical proposition as a vehicle for every day use, efficiencies of solar photovoltaic cells are rising all the time whilst their cost is decreasing. The concept of using solar cells, which can be wrapped to the surface of the car to keep the batteries of a commuter vehicle topped up, is a perfectly feasible idea, and as the cost falls and the efficiency increases may one day prove a practical proposition.

F. Electric Vehicles Using Flywheels:

There have been various alternative energy storage devices including the flywheel and super capacitors. As a general rule both of these devices have high specific powers, which means that they can take in and give out energy very quickly. However, the amount of energy they can store is currently rather small. In other words, although they have a good *power* density, they have a poor *energy* density.

A novel electric vehicle using a flywheel as an energy storage device was designed by John Parry, UK. The vehicle is essentially a tram in which the flywheel is speeded up by an electric motor. Power to achieve this is supplied when the tram rests whilst picking up passengers at one of its frequent stations. The tram is driven from the flywheel by an infinitely variable cone and ball gearbox. The tram is decelerated by using the gearbox to accelerate the flywheel and hence transfer the kinetic energy of the vehicle to the kinetic energy of the flywheel, an effective form of regenerative braking.

The inventor has proposed fitting both the flywheel and gearbox to a conventional battery powered car. The advantage of this is that batteries do not readily take up and give out energy quickly, whereas a flywheel can. Secondly the arrangement can be made to give a reasonably high efficiency of regeneration, which will help to reduce the battery mass.

Fig – 5: Flywheel Energy Storage

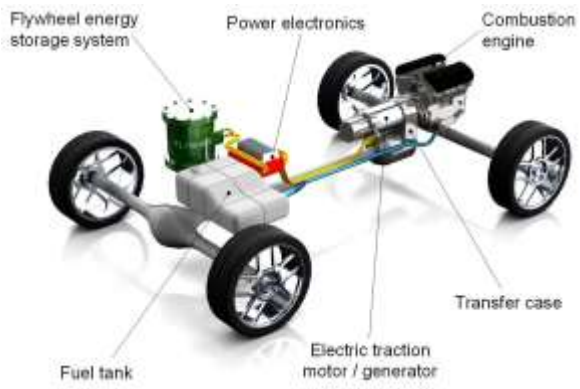

Fig – 6: FES Diagram

Advantages of Electric vehicles:

1. Electric vehicles are 75 percent efficient at turning input energy into moving energy. On the other hand, gas-powered vehicles with internal combustion engines (ICE) are only 25 percent efficient.

2. One of the primary reasons for the introduction of electric cars into the market is the concern over greenhouse gas emissions and their contribution to global warming.

3. Overall, electric car are significantly cleaner and safer for the environment than traditional gas cars. Electric cars don't require drilling for oil. Furthermore, they don't release tailpipe exhaust and they are super quite too.

4. The widespread introduction of electric cars has the potential to improve public health. One of the biggest negative impacts of internal combustion engine is the exhaust emissions. Not only it smell, but it's dirty and filled with harmful gases.

5. While electric cars have a higher initial cost than gas cars, they are usually more affordable in the long-term. In an overall cost-of-ownership view, EVs with similar features as gas powered cars are a lot more affordable.

6. It costs a lot less to maintain an electric vehicle than a traditional gas vehicle.

7. It costs a lot less to fuel electric cars than gas powered ones. Assuming electricity costs $0.11 per kilowatt-hour (kWh), and gas costs $3 a gallon.

8. The increased demand for electric cars has encouraged auto makers to get better at making them. This encourages innovation and economic growth.

Mobile Apps for EVs:

Many EVs today are technically advanced and have mobile apps that can provide you with information on your car such as how far you can drive given your current battery charge and even allow you to control your car like locking the doors or pre heating your car on a winter day. Be sure to check the app store of your mobile device for apps for your EV, for example Leaf Spy and VERNetwork.

Fig – 7: Leaf Spy App and VERNetwork App

Design of Concept Cars:

A concept car (also known as a concept vehicle, show vehicle or prototype) is a car made to showcase new styling and/or new technology. They are often shown at motor shows to gauge customer reaction to new and radical designs which may or may not be mass-produced. General Motors designer Harley Earl is generally credited with inventing the concept car, and did much to popularize it through its traveling Motorama shows of the 1950s.

Concept cars never go into production directly. In modern times all would have to undergo many changes before the design is finalized for the sake of practicality, safety, regulatory compliance, and cost. A "production-intent" prototype, as opposed to a concept vehicle, serves this purpose.

- **Design:**

Concept cars are often radical in engine or design. Some use non-traditional, exotic, or expensive materials, ranging from paper to carbon fiber to refined alloys. Others have unique layouts, such as gullwing doors, 3 or 5 (or more) wheels, or special abilities not usually found on cars. Because of these often impractical or unprofitable leanings, many concept cars never get past scale models, or even drawings in computer design. Other more traditional concepts can be developed into fully drivable (operational) vehicles with a working drivetrain and accessories. The state of most concept cars lies somewhere in between and does not represent the final product. A very small proportion of concept cars are functional to any useful extent, some cannot move safely at speeds above 10 miles per hour (16 km/h).

Inoperative "mock-ups" are usually made of wax, clay, metal, fiberglass, plastic or a combination thereof. If drivable, the drivetrain is often borrowed

from a production vehicle from the same company, or may have defects and imperfections in design. They can also be quite refined, such as General Motors' Cadillac Sixteen concept. After a concept car's useful life is over, the cars are usually destroyed. Some survive, however, either in a company's museum or hidden away in storage. One unused but operational concept car that languished for years in the North Hollywood, California, shop of car customizer George Barris, Ford Motor Company's "Lincoln Futura" from 1954, received a new lease on life as the Batmobile in the *Batman* series that debuted in 1966 on the ABC Television Network.

A concept car is designed in Solidworks 2016. The overview of the design is given below:

Fig – 8: Overview of concept car in Solidworks

Fig – 9: Overview in Rendering

CONCLUSION:

The future of electric vehicles, both in the short and the long term is very exciting. There have been considerable developments in technology, which now allow advances in electric vehicle design to be made. There are growing environmental concerns which are pressing society to find alternatives to IC engines alone as a source of power for vehicles. Environmental concerns encompass worries about carbon dioxide emissions and the effect of exhaust gas emissions on health.

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