Innovations in Hybrid Electric Light Motor Vehicle and its Sub Systems: A Study

Suresh Kumar Subbarayalu
Muralidhar Manapuram

Research Scholar, Dept. of Mechanical Engineering, North Eastern Regional Institute of Science and Technology, Nirjuli, Itanagar, Arunachal Pradesh-791109, India
Professor, Dept. of Mechanical Engineering, North Eastern Regional Institute of Science and Technology, Nirjuli, Itanagar, Arunachal Pradesh-791109, India

ABSTRACT

India is the fourth largest light motor vehicles (LMVs) population in the world. Currently it produces around 4 million vehicles per annum and cumulative LMVs include 30 million. Most of the IC engines are operated by fossil fuels which emits greenhouse gases which accounts for 13% related to CO2 emissions. Innovations in LMVs and their sub-systems are highlighted. In the present work an attempt has been made to study innovations in electric light motor vehicles as an alternative to internal combustion engine vehicles. Some useful conclusions are arrived at.

Key words: Electric Hybrid Light Motor Vehicle, Electric Vehicle Configurations, Internal Combustion Engine, Innovative Propulsion.

1.0 INTRODUCTION

The first car in India that plied on Indian roads was as early as 1897 AD and the first Indian to own a car was Jamshedji Tata in 1901 AD .The first car was built [1] by Hindustan Motors, with collaboration with Morris Motors, UK in 1942 AD. India is the fourth largest LMV producer in the world with an annual production of 4 million and cumulative plied vehicles of 30 million which operated by internal combustion engines (ICE). The ICEs produce greenhouse gases which account for 13% of CO_2. Electric vehicles address this problem.

The basic principle behind the electric vehicle is converting chemical energy into kinetic energy where chemical energy stored in a battery and kinetic energy produced by an electric motor. With soaring oil prices and poor air quality index around the world made electric vehicles as favoured choice for cheaper alternatives and environmental friendly in recent years. Electric vehicles were developed before the invention of internal combustion engine (ICEV) vehicles. The British inventor Robert Anderson designed and manufactured the first electric vehicle in 1832 AD and later became popular at the fag end of the 19th century [2]. Due to fallout of oil prices and urges for longer drive distance has developed ICEVs at faster rate at the beginning of the 20th century. A Model T, an ICEV was mass-produced by Henry Ford in 1908 AD but later on ICE have grown significantly because of limited battery capacity of an electric vehicle these could not able to achieve long distance travel.

2.0 INNOVATIONS OF ELECTRIC LMV AND ITS TIME LINE

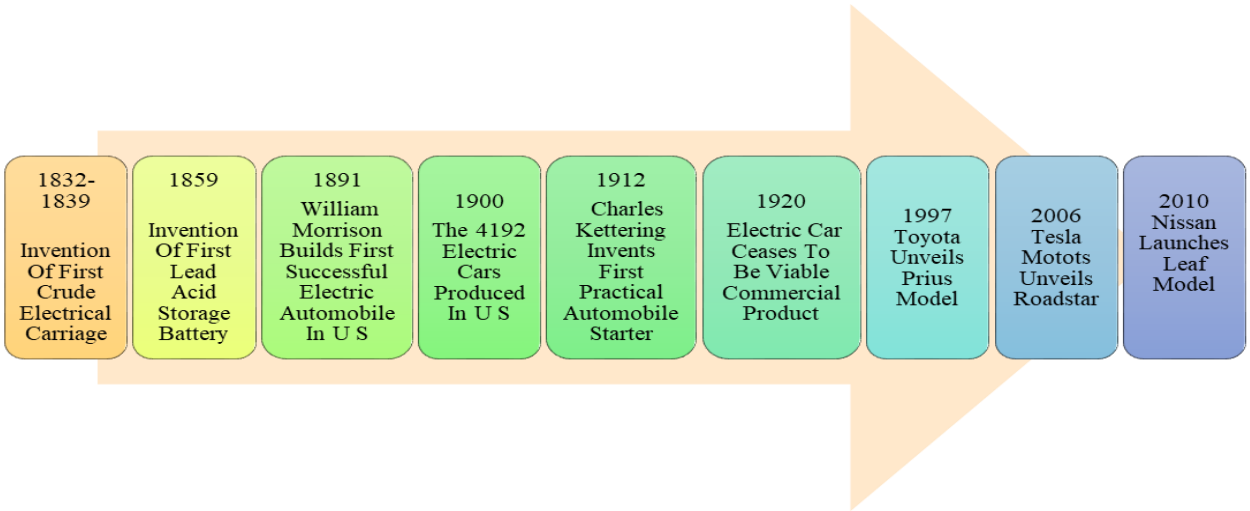

Fig 1 Innovations of Electric LMV Time Line

The innovations of electric light motor vehicle [3] is depicted in Figure 1. Decline of electric vehicles had started due to invention of electric automobile starter by Charles Kettring in 1912 AD. During the 1920s the electric car ceases to be a commercial viable product and its downfall is necessitated by number of factors including desire for longer distance and readily availability of fuel with limited

horsepower. Toyota unveils Pirus new model of electric vehicle and sold 18,000 units in 1997 AD and followed by Tesla Motors launched Roadstar in 2006 AD. Later Nissan company revealed its new electric car namely 'Leaf" capable of achieving maximum speed 140 kmph and can travel 160 kms on a full charge.

3.0 INTERNAL COMBUSTION ENGINES AND ITS SUB SYSTEMS FOR LIGHT MOTOR VECHICLES

Light Motor Vehicle (LMV) system [4,5] consists of chassis, engine, electrical system, transmission system, suspension system, brake system and body. The chassis houses engine, transmission system, suspension system, steering system and brakes. The engine provides the motive power for all the various functions which the vehicle may be called upon to perform. Generally engine consists of an internal combustion engine which may either spark ignition or compression ignition engine.

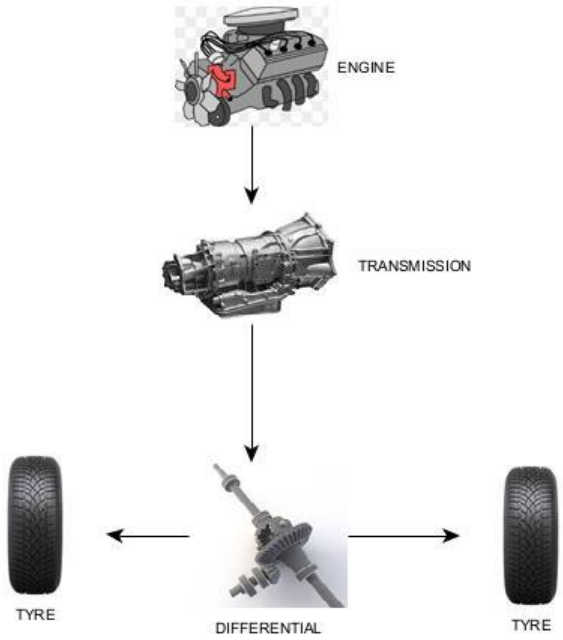

Fig 2 LMV Sub Systems

The electrical system gives electricity for cranking the engine, charging the battery and gives power to lighting and other accessories. The transmission system consists of a clutch, a gearbox provides different ratios of torque output, a propeller shaft to transmit the torque from gear box to rear axle and differential gear to driving wheels. The suspension system, which absorbs the shock of the tires and wheels meeting uneven surface of the road. The brake system is provided to stop the vehicle within the smallest possible distance. The body provides compartments for the engine, passengers and luggage or cargo.

4.0 INNOVATIONS IN ELECTRIC LIGHT MOTOR VEHICLE AND ITS SUB SYSTEMS

4.1 Electric Vehicle (EV): An electric light motor vehicle (Fig. 3) is driven by an electric motor, powered by rechargeable battery packs, without internal combustion engine coupled with transmission including differential.

Battery: It powers electric motor for movement of vehicle.

Power Converter: The electrical energy stored in a battery is fixed DC which should be transformed to either variable AC or Variable DC which depends on the kind of electric motor which provides the power to the wheels.

Electric Motor: The motor converts electrical energy that it gets from the battery into mechanical energy which enables the vehicle to move. It also perform as a generator in the course of regenerative action which returns energy to the energy source.

Transmission: The gear box is also called as Transmission which allows transfer of power from engine to wheels.

Drive Train: The combination of electric motor, transmission is referred as drive train.

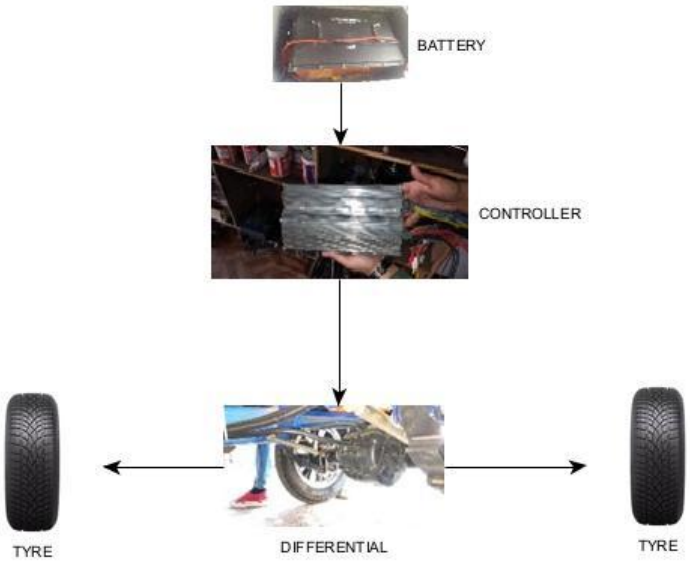

Fig 3. ELMV Subsystems

4.2 Hybrid Electric Vehicle (HEV):

HEVs (Fig. 4) propelled by both an ICE and an electrical power train to power the vehicle. An HEV utilize the electric propulsion system although the demand of power is low. Five main parts make up the hybrid vehicle which includes battery, internal combustion engine (ICE), generator, power split device and electric motor. The electric motor derived energy from energy storage device called batteries in a hybrid car.The HEV switches to the ICE when the vehicle needs higher speed. The tandum drive trains can also work simultaneously to improve the performance. Hybrid power systems are used widely to diminish or to take away the turbo delay in turbocharged cars, namely the Acura NSX. It also augment performance by bridging the gaps between gear shifts and providing speed boosts when required. The batteries are charged by ICE, the regenerative braking is used in HEVs to recover energy. Consequently, HEVs are predominantly ICE powered cars that use an electrical drive train to enhance the mileage or for performance enhancement. To achieve these features, the car manufactures broadly embracing the HEV configurations .The propulsion of ICE works as the motor as a generator to produce some power and store it in the battery. In order to get cruising speed in the hybrid vehicles both ICE and motor drives the power train. In the course of braking the power train drives the motor as generator to charge the battery by regenerative braking. While cruising, ICE runs the both the vehicle and the motor as generator, which charges the battery. The power flow is stopped once the vehicle stops.

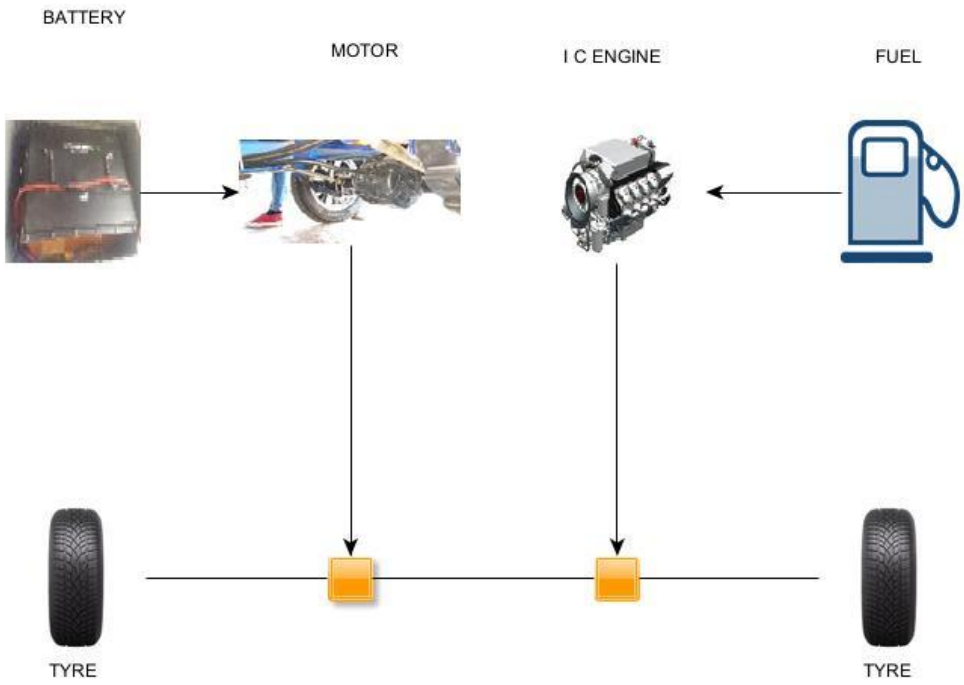

Fig 4. Parts of a hybrid Light Motor vehicle

When the driver steps on the pedal the generator converts energy from the engine into electricity and stores it in the battery. The electric motor derives the power from the battery. The power split device derives the power from both internal combustion engine and electric motor which work altogether .The power split device merge both powers and utilizes it to turn the transmission. The transmission then drives the wheels and move the vehicle. Although the vehicle stopped, the electric motor and gasoline engine automatically shut off such that energy is not wasted during idling. The auxiliary systems namely air conditioning and dashboard displays continuously draws the power from battery. The hybrid vehicle (HV) is operated by both electric motor and gasoline engine. The engine provides most of the vehicle's power, and the electric motor provides additional power when needed, such as accelerating and crusing. In the urban areas where low speed conditions and traffic jams the fuel consumption may get reduced even as the engine stays totally off it is a great advantage in low speed conditions like urban areas; it also reduces the fuel consumption as the engine stays totally off in the course of idling periods. This in turn will reduce the GHG emission.

5.0 CONCLUSIONS:

Innovative developments with reference to timeline, electric vehicles, hybrid electric vehicles and their sub-systems to address GHG problem and depleting gasoline were highlighted for LMVs of India. Electric LMVs are expected to grow continuously in near future. Innovations in propulsion of LMVs were highlighted suitable for Indian conditions.

ACKNOWLEDGMENT

Authors would like to express sincere thanks to Department of Mechanical Engineering, North Eastern Regional Institute of Science and Technology (Deemed to be University), Nirjuli, Itanagar, Arunachal Pradesh, India for the necessary help rendered in the present work.

REFERENCES

[1] Indian automobile industry analysis, https://www.siam.in

[2] R.Matulka,"The History of the Electric Car," *Energy Gov 2014*, 1–11. DOI:10.1049/ip-a-1.1985.0014, 2014.

[3] C. C. Chan, "The Rise and Fall of Electric Vehicles in 1828-1930: Lessons Learned," Proc IEEE 2013,Vol.101,206-212,DOI:10.1109/JPROC.2012.2228370, 2013.

[4] Rony Arguta., A Technical Research Report: The Electric Vehicle, 2010.

[5] Saurabh Chauhan, "Motor Torque Calculations for Electric Vehicle" International Journal of Scientific and Research, Volume 4, Issue 08, August 2015.