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DESIGN OF HYBRID POWER TRANSMISSION

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ABSTRACT:
In automobile sector, the need for alternative fuel as a replacement of conventional fossil fuel, due to its depletion and amount of emission has given way for new technologies like hybrid. Still a lot of advancementhas to take place in these technologies for commercialization. The gap between the current fossil fuel technology and zero emission vehicles can be bridged by hybrid technology. Hybrid vehicles are those which can run on two or more powering sources fuels. This technology maximizes the advantages of the two fuels and minimizes the disadvantages of the same. The best preferred hybrid pair is electric and fossil fuel. In this paper the Hybrid Power transmission system, the power is delivered both via an internal combustion engine and electric motor. The electrical power is used to achieve either better fuel economy than a conventional vehicle, better performance and it cause less pollution. Driving mode selectivity improves this system more economical, stable and more efficient.

KEYWORDS:*. Internal combustion engine, Electric motor, Fuel economy, Dual mode vehicles.*

1. Introduction

Around 93% of today's automobiles run on petroleum based product, which are estimated to be depleted by 2050. Moreover, current automobiles utilize only 25% of the energy released from petroleum and rest is wasted into the atmosphere. Despite recent efforts to improve fuel efficiency and reduce toxic emissions in cars, emissions have continued to increase steadily in the past two decades.

For preservation of gasoline for future and increasing the efficiency of vehicle an electric vehicle can be a major breakthrough. An hybrid power transmission is eco-friendly and is efficient at low speed conditions mainly in high traffic areas. But battery charging is time consuming. Moreover, it cannot provide high power required by drives during high speed conditions or in slopes of hilly areas. Gasoline engine proves its efficiency at higher speeds in high ways and waste a lot of energy in urban areas. A hybrid power transmission solves these problems by combining the advantages of both the systems and uses both the power sources at their efficient conditions. The objective of this project aims at better utilization of fuel energy and reduces dependence on non-renewable resources using latest technology. The implementation involves development of HEV that uses battery as well as gasoline power for propulsion of vehicle.

2. What is hybrid power transmission?

Hybrid means combination of two or more than two power sources for driving of our vehicle, which we can combine gasoline and electricity, wind and electricity, CNG and gasoline etc. such power sources are used for hybrid vehicle which is taking the automobile towards new possibilities and new emerging morning. Hybrid are ecofriendly vehicle having less emission and less harmful to environment.

A. Types of hybrid transmission

1) Parallel type

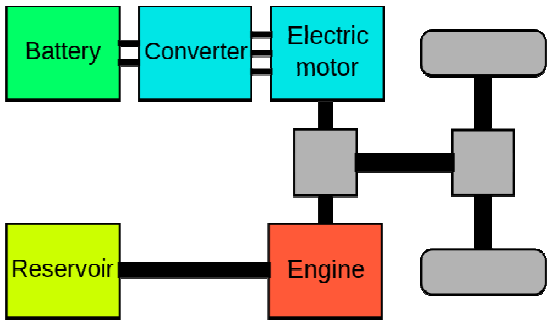

Fig. 1- Parallel type

Parallel hybrid systems, the most common as of 2016, have both an ICE and a coupled electric motor.If they are joined at an axis (in parallel), the speeds at this axis must be identical and the supplied torques add together. (Most electric bicycles are of this type.) When only one of the two sources is in use, the other must either also rotate

(idle), be connected by a one-way clutch or freewheel.

With cars the two sources may be applied to the same shaft (for example with the electric motor connected between the engine and transmission), turning at equal speeds and the torques adding up with the electric motor adding or subtracting torque to the system as necessary. (The Honda Insight uses this system.) Parallel hybrids can be further categorized by the balance between the different motors are at providing motive power: the ICE may be dominant (engaging the electric motor only in specific circumstances) or vice versa; while in others can run on the electric system alone but because current parallel hybrids are unable to provide electric-only or internal combustion-only modes they are often categorized as **mild hybrids** (see below). Parallel hybrids rely more on regenerative braking and the ICE can also act as a generator for supplemental recharging. This makes them more efficient in urban 'stop-and-go' conditions. They use a smaller battery pack than other hybrids. Honda's Insight, Civic, and Accord hybrids are examples of production parallel hybrids.[2] General Motors Parallel Hybrid Truck (PHT) and BAS Hybrids such as the Saturn VUE and Aura Greenline and Chevrolet Malibu hybrids also employ a parallel hybrid architecture.

2) Series type

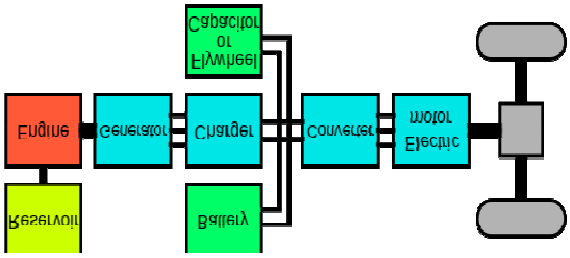

Fig.2 Series type

Series hybrids are also referred to as extended-range electric vehicles (EREV)[5] or range-extended electric vehicles (REEV). (Series hybrids with particular characteristics are classified as range-extended battery-electric vehicle (BEVx) by the California Air Resources Board.[6]) Electric transmission has been available as an alternative to conventional mechanical transmissions since 1903. Typically mechanical transmissions impose many penalties, including weight, bulk, noise, cost, complexity and a drain on engine power with every gear-change, whether accomplished manually or automatically. Unlike ICEs, electric motors do not require a transmission. In effect the entire mechanical transmission between the ICE and the wheels is removed and replaced by an electric generator, some cable and controls, and electric traction motors, with the benefit that the ICE is no longer directly connected to the demand. This is a series-hybrid arrangement and is common in diesel-electric locomotives and ships (the Russian river ship Vandal launched in 1903, was the world's first diesel-powered and diesel-electric powered vessel) and Ferdinand Porsche successfully used this arrangement in the early 20th century in racing cars, including the Lohner-Porsche Mixte Hybrid. Porsche named the system SystemMixte, which had a wheel hub motor arrangement, with a motor in each of the two front wheels, setting speed records.

The arguments of greater flexibility, higher efficiency and less emissions at the point of use are achieved in a series-hybrid system for road vehicles when an intermediate electric battery, acting as an energy buffer, sits between the electric generator and the electric traction motors.

The ICE turns a generator and is not mechanically connected to the driving wheels. This isolates the engine from demand, allowing it to consistently operate at its most efficient speed. Since the primary motive power is generated by the battery, a smaller generator/engine can be fitted as compared to a conventional direct drive engine. Electric traction motors can receive electricity from the battery, or directly from the engine/generator or both. Traction motors frequently are powered only by the electric battery, which can be charged from external sources such as the electricity grid.

3. Review of Literature

The literature search was mainly focused on topics related to Electric and Hybrid cars. The review of publications and research work revealed the basic guidelines and area of work need to be conducted exhaustively on a particular model of car, where positive result is expected, in favour of society and future demand for saving of fossil fuel and environment pollution point of view.

The research papers available for viewing and reference on internet search engines and through related websites for the knowledge and information sharing on public domain is cited below. The literature search was mainly focused on topics related to Electric Vehicles (EV), Hybrid Electric Vehicles (HEV) and Fuel Cell Powered Hybrid Electric Vehicles (FCHEV). The publications related to simulation, critical analysis and empirical study using available software were reviewed in detail. Also, study of vehicular propulsion 8 systems based on alternate sources of energy was attempted to a certain extent; however it was restricted more importantly to the literature related to fuel saving objectives, rather than research work carried out for reduction in constituents of harmful pollutant exhaust gas emission perspective and saving of environment against global warming.

Since, the objective of the proposed work is to save fuel consumption on existing cars, which will automatically have crucial impact on the automotive emission; the main attention was paid to review of literature on the work carried out in the past by learned researchers in the field of fuel saving.

4. Elements and Working Of Hybrid Power Transmission System

a)Engine-An internal combustion engine (ICE) is a heat engine where 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 high-temperature 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, rotor or a nozzle. This force moves the component over a distance, transforming chemical energy into useful mechanical energy.

Table No. 1.-Specification of Engine

Sr. no.	Content	Description
1	Engine	Briggs and Stratton 208 cc ,6.5 HP, 16 Kg
2	Engine Type	OHV 950 Series
3	Max. Torque	12.86 Nm @ 3600 rpm
4	Lubrication	Splash
5	Fuel type	Gasoline
6	Fuel tank capacity	3 ¼
7	Engine Displacement(cc)	208

b)BLDC Motor-Brushless DC electric motor (BLDC motors, BL motors) also known as electronically commutated motors (ECMs, EC motors) are synchronous motors powered by DC electricity via an inverter/switching power supply which produces an AC/bi-directional electric current to drive each phase of the motor via a closed loop controller. The controller times commutation (hence rpm) and creates current waveforms (hence torque). In this context alternating current does not imply but does include a sinusoidal waveform, with minimal restriction on waveform; it must be periodic, and its frequency will determine motor rpm, and the waveform does effect how smooth the generated torque is as well as the motors efficiency at transforming electrical to mechanical energy. In a well design PMSM the air gap magnetic flux is spatial sinusoidal and the phase commutation currents are sinusoidal, ninety degrees out of phase.

c)Gear Box-

A transmission is a machine in a power transmission system, which provides controlled application of the power. Often the term transmission refers simply to the gearbox that uses gears and gear
trains toprovide speed and torque conversions from a rotating power source to another device.
In British English, the term *transmission* refers to the whole drivetrain, including clutch, gearbox, prop shaft (for rear-wheel drive), differential, and final drive shafts. In American English, however, the term refers more specifically to the gearbox alone, and detailed usage differs. The most common use is in motor vehicles, where the transmission adapts the output of the internal combustion engine to the drive wheels. Such engines need to operate at a relatively high rotational speed, which is inappropriate for starting, stopping, and slower travel. The transmission reduces the higher engine speed to the slower wheel speed, increasing torque in the process. Transmissions are also used on pedal bicycles, fixed machines, and where different rotational speeds and torques are adapted.

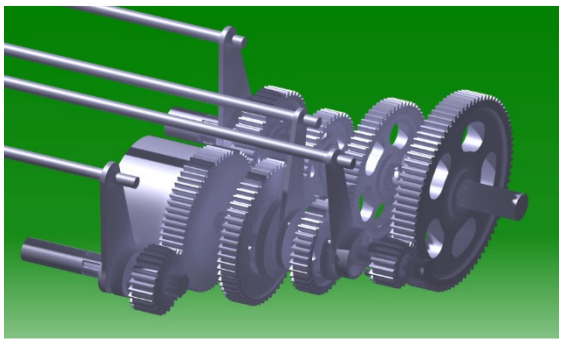

Fig 3: CATIA Model of Gear Drive

Table No. 2-Gear Reduction Ratio

Gear	**Ratio**
First gear	18
Second gear	6
Third gear	2.5

e) Chain and sprocket-

A sprocket or sprocket-wheel is a profiled wheel with teeth, cogs, or even sprockets that mesh with a chain, track or other perforated or indented material. The name 'sprocket' applies generally to any wheel upon which radial projections engage a chain passing over it. It is distinguished from a gear

in that sprockets are never meshed together directly, and differs from a pulley in that sprockets have teeth and pulleys are smooth.

f) Multiplate clutch-This type of clutch has several driving members interleaved or "stacked" with several driven members. It is used in racing cars including Formula 1, Indy Car, World Rally and even most club racing. Multiplate clutches see much use in drag racing, which requires the best acceleration possible, and is notorious for the abuse the clutch is subjected to. Thus motorcycles, automatic transmissions and in some diesel locomotives with mechanical transmissions. It is also used in some electronically controlled all-wheel drive systems as well as in some transfer cases. They can also be found in some heavy machinery suchas tanks and AFV's and earthmoving equipment (front-end loaders, bulldozers), as well as components in certain types of limited slip differentials. The benefit in the case of motorsports is that you can achieve the same total friction force with a much smaller overall diameter (or conversely, a much greater friction force for the same diameter, important in cases where a vehicle is modified with greater power, yet the maximum physical size of the clutch unit is constrained by the clutch housing). In motorsports vehicles that run at high engine/drivetrain speeds, the smaller diameter reduces rotational inertia, making the drivetrain components accelerate more rapidly, as well as reducing the angular velocity of the outer areas of the clutch unit, which could become highly stressed and fail at the extremely high drivetrain rotational rates achieved in sports such as Formula 1 or drag racing. In the case of heavy equipment, which often deal with very high torque forces and drivetrain loads, a single plate clutch of the necessary strength would be too large to easily package as a component of the driveline.

g)Belt drive

Timing belts (also known as toothed, notch, cog, or synchronous belts) are a *positive* transfer belt and can track relative movement. These belts have teeth that fit into a matching toothed pulley. When correctly tensioned, they have no slippage, run at constant speed, and are often used to transfer direct motion for indexing or timing purposes (hence their name). They are often used in lieu of chains or gears, so there is less noise and a lubrication bath is not necessary. Camshafts of automobiles, miniature timing systems, and stepper motors often utilize these belts. Timing belts need the least tension of all belts, and are among the most efficient. They can bear up to 200 HP (150 kW) at speeds of 16,000 ft./min (4,900 m/min). Timing belts with a helical offset tooth design are available. The helical offset tooth design forms a chevron pattern and causes the teeth to engage progressively. The chevron pattern design is self-aligning and does not make the noise that some timing belts make at certain speeds, and is more efficient at transferring power (up to 98%).

I. Hybrid vehicle operation mode
II. Hybrid vehicles can be used in different modes. The figure shows some typical modes for a parallel hybrid configuration.

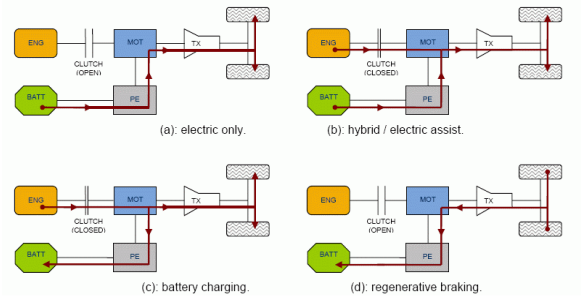

Fig. 4- Hybrid vehicle operation mode

Characteristics of Hybrid Systems

Hybrid systems possess the following four characteristics:

1) Energy-Loss Reduction The system automatically stops the idling of the engine (idling stop), thus reducing the energy that would normally be wasted.

2) Energy Recovery and Reuse- The energy that would normally be wasted as heat during deceleration and braking is recovered as electrical energy, which is then used to power the starter and the electric motor.

3) Motor Assist: The electric motor assists the engine during acceleration.

4) High-Efficiency: Operation Control The system maximizes the vehicle's overall efficiency by using the electric motor to run the vehicle under operating conditions in which the engine's efficiency is low and by generating electricity under operating conditions in which the engine's efficiency is high. The series/parallel hybrid system has all of these characteristics and therefore provides both superior fuel efficiency and driving performance.

4. Future scope

Automobiles of the future must increase both environmental and safety performance, while significantly increasing the all-important motor vehicle characteristic of being fun to drive. To achieve superior driving performance, which is the basis for driving enjoyment, the conventional approach has been to increase output and torque by

increasing engine displacement or using supercharging. However, this approach decreases fuel efficiency, making it difficult to achieve compatibility of environmental performance and power. In other words, fuel efficiency and power are in a trade-off relationship. By using the Toyota Hybrid System (THS), the Prius was able to escape the inevitability of this relationship in a paradigm shift. The goal of the Hybrid Synergy Drive concept is to achieve compatibility of high levels of both environmental performance and power. THS, which is a series parallel hybrid, contains a power split device that splits power into two paths. In one path, the power from the gasoline engine is directly transmitted to the vehicle's wheels. In the other path (electrical path), the power from the engine is converted into electricity by a generator to drive an electric motor or to charge the battery. This unique configuration achieves idling stop, stopping of the gasoline engine while the vehicle is running, running of the vehicle using the electric motor, motor assist at any speed, and highly efficient energy regeneration, without using a clutch or transmission. This is achieved through the use of a motor having large low-speed torque and large output. The newly developed hybrid system, THS II, targets both greater power and improved motor power transmission efficiency, advancing energy management control for the entire vehicle. As a result, Hybrid Synergy Drive has been developed, which markedly increases power performance, improves acceleration performance, and at the same time achieves the highest degree of environmental performance in the world.

Advantages and Disadvantages Series transmission

A. Advantages

I. Mechanical decoupling of the engine from the drivewheels allows operation anywhere on its speed-powercurve – can aim for optimum operation as much aspossible
II. Electric motors spin to very high rpm – therefore thetransmission unit requires less gears, is cheaper, andlighter
III. Can use one electric motor per wheel – implicationsfor AWD, traction and stability control
IV. Control systems are relatively simple

B. Disadvantages

I. ICE energy converted twice (mechanical to
II. electrical to mechanical) and therefore losses canbe significant
III. Requires a generator and its associated cost andweight
IV. Requires a large electric motor since it is the onlypowerplant directly propelling the vehicle
V. Requires a full-sized ICE if battery does not have ahigh storage capacity (e.g., is not a PHEV).

Advantages and DisadvantagesParallel transmission

A. Advantages

I. Speeds and Torques of the two powerplants can be
II. chosen independently (within constraints)
III. The powerplants can be smaller, and thereforecheaper and more efficient

B. Disadvantages

More complex than series – in particular, control isfar more complexPower-S

5. CONCLUSION

The Hybrid power transmission is an optimized combination of two continuously variable operating ranges and fixed gear ratios for parallel and series hybrid operation. It is particularly appropriate for full-size SUV (Sport-Utility Vehicle), which have substantial towing capacity and large engines. The Hybrid power transmission of greater ability to transmit power mechanically, minimizing engine power conversion to electricity and back again. The addition of fixed gear ratios in the Hybrid allows the system and to select either variable modes or fixed gears for the highest fuel economy under widely varying conditions, maximizing its fuel economy improvement and best meeting the challenges of demanding SUV driving

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