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Design of Planetary Gear Transmission System for Hybrid Scooter

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Abstract— This paper presents a systematic design methodology of planetary gear transmission system for hybrid scooter. Thedesign methodology consists of analyzing the planetary gear transmission system and designing the hybrid transmission system using planetary gearset. The transmission system designed here is a four stage planetary gear system in which each planetary gearset consists of a sun gear, three planet gears and a planet carrier. The hybrid power systems involved here are an IC Engine and an electric motor. This transmission system works on power mode of hybrid transmission where the combined powers of engine and motor can be taken as output from the planetary gear transmission system.

Index Terms— HEV, planetary gear set, hybrid technology, sun gear, planet gear, carrier, reduction ratio, analysis

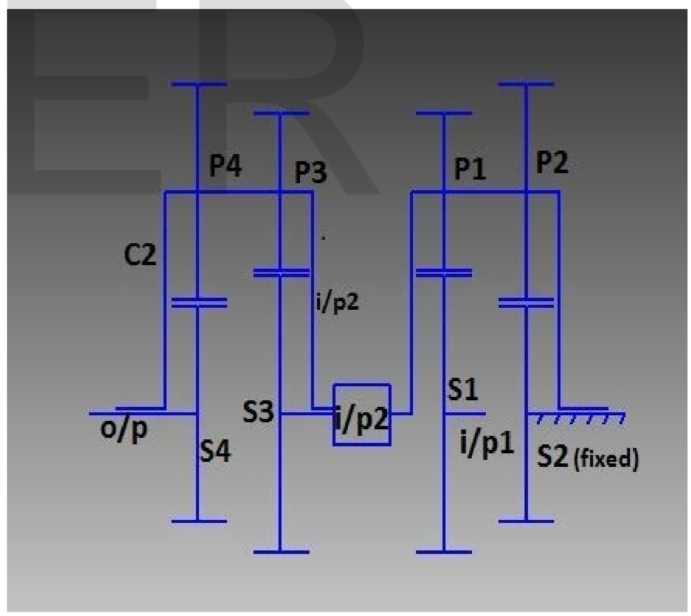
1 INTRODUCTION

The hybrid electric vehicles have dominated in the automobile markets in the world. Most of the hybrid electric vehicles available are usually four wheelers. But the availability of hybrid scooters are less.we introduce a newhybrid scooter which contain a planetry gear set up. The planetry gear consist of mainly sun gear , planetry gear and ring gear. But here we avoid the ring gear and we use the sun and planetry gear setup. A planetry carrier is introducing into it for taking the output. The main aim of this project is to through this design set up we can reduce the pollution rate and the consumption of fuel. Planetary gears are widely used in the transmissions like helicopters, aircraft engines, heavy machinery and marine vehicles etc also. The energy density of electric batteries will never equalthat of liquid or gaseous fuels, so that these fuels will inevitably remain a critical part offuture vehicles to maintain the driving range and quick refuelling of today's conventionalvehicles. Vibration reduction in planetary gears provides substantial benefits: reduced noise, improved reliability, more efficient power transfer, and reduced maintenance costs.

2 LITERATURE REVIEW

The idea of this topic will be raise out on before 1990s . but this research on this topic was more elaborated after 1990. At first the scientist studied about the thirteen degree of freedom system and identified the natural frequencies and vibration modes. Then the research for the thirteen degree of freedom system and identified the natural frequencies and vibration modes are to be conducted. The main problem for this is the how design parameters affect the natural frequencies and vibration modes. After 1990s the research will be conducted and papers will published on planetry gear dynamics, ie about the nonlinear, time-varying planar dynamic model and subsequently extended it to three-dimensions and examined the influence of planet phasing on dynamic response. Using these models, Kahraman and Blankenship investigated the load sharing and mesh phasing among planets. Kahraman reduced his model to a purely torsional one to predict natural frequencies and vibration modes. Other studies of planetary gear dynamics include mess stiffness variation and load-sharing , influence of some design parameters on tooth loading and mesh parametric excitation.

3 CONSTRUCTION AND WORKING



Schematic diagram of transmission system

The planetry gear box contain four sun gear and four set where each set of three planet gears and the carriers are attached to it. The gear system are arranged in two sections. The power from the IC Engine is given to the sun gear one (S_1), then the planetry gear one(P_1) will rotate and the gear S_2 and P_2 will rotate. The S_2 and S_3 are connected through a hollow shaft . when S_2 will rotate S_3 will also rotate and the P_3 will also rotate. The motor will be connected to the gear C_2 , this combined power will help to rotate the gear P_4 and S_4 . The output power will taken from two way that is from carrier C_2

and sun gear (S_4). In this set up we take the power from the sun gear (S_4).

4 LAYOUT ON HYBRID TECHNOLOGY

The International Electrotechnical Commission (IEC) defines a hybrid vehicle as: "one in which propulsion energy, during specified operational missions, is available from two or more kinds or types of energy stores, sources, or converters. At least one store or converter must be on board. A hybrid electric vehicle (HEV) is a hybrid vehicle in which at least one of the energy stores, sources, or converters can deliver electric energy. A series hybrid is an HEV in which only one energy converter can provide propulsion power. A parallel hybrid is an HEV in which more than one energy converter can provide propulsion power."

The hybrid technology is of earlierly two types, parallel and series hybrid system. The recently developed technology is the power split hybrid which uses the planetary gear drive. The dual-power (or dual-mode) system, which is not a hybrid powertrain is the simplest configuration because the individual drive components are completely independent and provide the mechanical power separately. This system usuallyconsists of a group of electric drive-batteries working when driving in urban areas and an ICE working on non-urban roads. Any kind of co-operation between the two drive systems is excluded. The engine can even work at its optimum operating point in terms of efficiency oremissions. In particular, due to the elimination of too rapidly changing. In the series arrangement, the individual drive components are connected in series withoutany mechanical linkage of the engine to the driving wheels. The fuel converter is usually asmall ICE whose main function is to extend the vehicle range. When the state of charge (SOC) of the storage device reaches a specified lower limit, the fuel converter engages torecharge it driving a generator which supplies the electrical motor and the storage device(usually a pack of batteries). As the ICE in the series arrangement is mechanically decoupled from the vehicle drive, it ispossible to let it work with a sluggish dynamical behaviour generating the average powerrequired by the trip or following a suitable characteristic line of maximal effinamic, in citydriving the emissions can be strongly reduced and fuel economy is better than in a conventional powertrain, but if the vehicle is to achieve anything near the performance ofconventionally powered vehicles not only in short city trips but also in long-distance highway driving, its batteries and motor must be very large. A main disadvantage of this drive train is the double energy conversion, from mechanicalto electrical and vice versa, and its inevitable long "chain" of efficiency loss. All thermalenergy is converted first into mechanical energy in the ICE or gas turbine and further intoelectrical energy in the generator. Including the battery storage efficiency, the mechanicalefficiency between the ICE and the drive axle is hardly greater than

The parallel arrangement has been developed starting from the traditional vehicle equipped with an ICE. In its basic configuration the ICE and the electric drive are coupled to the same traction axle by a suitable mechanical transmission. The traction torque can be provided by the ICE and by the electric drive, simultaneously or individually, depending on the control strategy. A common scheme is to use the electric motor for city driving (restricted, emissionfree operation) and both the engine and the motor for highway driving. The engine can then both power the vehicle and recharge the battery pack, using the motor as a generator. The ICE cannot operate at a constant speed and has a dynamical behaviour not very different from that of a common thermal engine in automotive application. The parallel hybrid drive shows a purely mechanical power addition and transmission from the energy converters to the wheels, and thus converters of relatively small power can be chosen without losing performance in acceleration or climbing. The parallel drives can be divided into torque, speed and traction-power (when the electric motor and the engine act on different drive axles) addition designs. In the torque addition configuration (realised with transmission chain or helical gear) the speed values of both motors have always the same relation to each other and the torque values can change freely. A decoupling of both the drives can be obtained with a clutch. The traction-power addition is a kind of torque addition, where the two energy converters work on different axles of the vehicle (e.g. the engine on the front one, the motor on the rear one).

The speed addition can only be realised by planetary gears (e.g. in the Toyota *Prius*) in which the torque values of all the shafts have a constant relation to each other and the speeds of the drives can change freely. A more complex powertrain arrangement is provided by the "Power-Split Hybrid", quoted in the German technical literature too (*leistungsverzweigender Hybridantrieb*). In these structures the ICE power is partly transmitted directly to the wheels and partly to a generator, through a planetary gear set. An electrical drive provides torque to a traction axle. With this arrangement of the electric motors the system behaves like a continuously changeable gearbox and no additional gearbox is necessary for the engine. The speed and power produced by the engine can be independent of the remaining drives, and as the power is partially transmitted directly to the wheels the whole efficiency may be higher than in a series arrangement.
Differences about the dimension of the electrical power installed and the storage capacity of electrical energy among the various arrangements of hybrid powertrains produce a further

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classification. A parallel hybrid with small installed power and narrow electrical-energystorage capacity is described as "Starter/Generator Hybrid". If the electrical-power dimension is a little greater, the arrangement is called "Power Assist Hybrid", and in connection with the electrical energy kept within the storage device it is called "Low Storage Hybrid". A series hybrid with a great battery and a small power generation unit, often called Auxiliary Power Unit (APU), is named "Range Extender". If the energy kept within the batteries is low, and consequently the emission-free range is limited, the powertrain is called "Low Storage Hybrid". The German literature describes a hybrid powertrain in which the electrical storage devices are not charged from the power network, like "Autarkic Hybrid" (*autarker Hybridantrieb*).

5 DESIGN AND ANALYSIS

The above fig shows the planetry gear transmission system. Here the gear set up is divided into two sections, section 1 and section 2. In this engine power is given at S_1 and motor power added at C_2.

SECTION 1

	S_1	P_1	P_2	S_2	C_1
$S_1 \rightarrow +1$	+1	$-r_1$	$-r_1$	$+r_1r_2$	0
+x	+ x	$-xr_1$	$-xr_1$	$+ xr_1r_2$	0
$C_1 \rightarrow +y$	y+x	$y-xr_1$	$y-xr_1$	$y+xr_1r_2$	+y

Here in section 1 the power is given to S_1 gear andthis power is then transmitted to the P_1 and then to the P_2.

$$y + xr_1r_2 = 0$$

$$y = -xr_1r_2$$

SECTION 2

	S_3	P_3	P_4	S_4	C_2
$S_3 \rightarrow +1$	+1	$-r_3$	$-r_3$	$+r_3r_4$	0
+x′	+ x′	$-x'r_3$	$-x'r_3$	$+ x'r_3r_4$	0
$C_1 \rightarrow +y'$	y′+x′	$-x'r_1$	$y'-x'r_1$	$y'+x'r_3r_4$	+y′

Consider the equation related to the design

$$y'+x' = -xr_1r_2$$

$$x' = -y'-xr_1r_2$$

$$= -(y'+xr_1r_2)$$

We are taking the combined power output from S_3, ie,

Output at $S_4 = y' + x'r_3r_4$

$$= y' - (xr_1r_2+y')r_3r_4$$

$$= y' - xr_1r_2r_3r_4 - y'r_3r_4$$

$$= y'(1 - r_3r_4) - xr_1r_2r_3r_4$$

Here in this equation , we know that we can got the combined power of the IC Engine and the Motor. If the r_3r_4 is greater greater than one then the two powers are adding, ie, we get the combined power of engine and motor.

$$r_1 = S_1/P_1$$

$$r_2 = P_2/S_2$$

$$r_3 = S_3/P_3$$

$$r_4 = P_4 / S_4$$

\`r′ represents the reduction ratio or gear ratio

\`S′ represents the sun gear, \`C′ represents the carrier and \`P′ reoresents the planet gear. C=0 which means the carrier is fixed.

6 Conclusion

This paper gives a brief idea about the planetary hybrid system which can be used in hybrid scooters. The use of hybrid technology reduces the pollution and fuel consumption of the conventional type vehicles with the use of electric motor.
In this paper we designed a four stage planetary gear train by eliminating the ring gear. Here we proved the extraction of combined power of engine and motor by analyzing the two sections of gear drives and finally reaches a equation which gives the combined power. Thus we aimed at reducing the fuel consumption and pollution using a hybrid technology.

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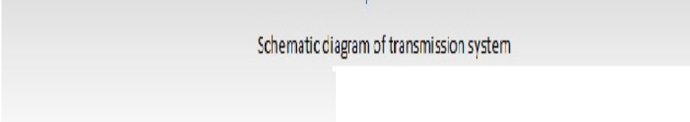

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