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Hybrid Vehicle Power Train

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ABSTRACT

The hybrid drive for transport vehicle with automatic change in gear ratio and torque moment with the help planetary gears with permanent mesh of gear wheels is suggested.

Keywords: hybrid drive, planetary differential, double acting electrical machine, electric induction connection, torque moment.

INTRODUCTION

Planetary gears are often used in modern hybrid vehicle powertrain. Very convenient to use, for example, is a simple planetary gear Simpson Simpson's gearbox [1]. The proposed in paper construction of the transmission has a goal of further development of this direction of the automatic transmission for a hybrid vehicle.

Purpose of the work provide a simple and reliable mechanism of transmission for hybrid vehicles with the lowest possible power consumption when driving. a simple and reliable mechanism of transmission for hybrid vehicles with the lowest possible power consumption when driving. With the simplicity of the device transmission, the proposed schemes connect of the motor and generator allows in motion and of the start to operate at the optimum mode. Such a connection is upgraded coupling mechanism, simplifies and optimizes the car start to repeatedly increase on the driven shaft torque. The existing problem of matching electric motor with constant speed varies widely turns the wheels also solved a similar mechanism incorporated into the drive electric motor. The construction is simple and reliable, contains no weak points, no gear shifting with disconnecting engine power from the driven shaft. The power transmitted from the engine is controlled smoothly in a wide range. The main advantage is that the most economy mode may be used at every operating stage.

CONNECTING THE ENGINE AND THE GENERATOR

The power train is comprised of three elements containing the differential mechanism. The main device is the differential which connects the engine and the generator with the subsequent power train elements [2]. The diagram shows activation of the differential and the generator on the Figure 1.

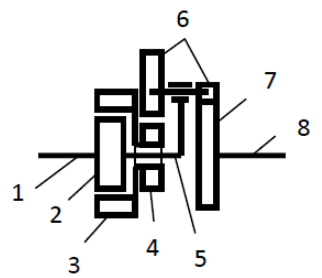

Figure1.

1. Engine shaft. 2. Generator rotor. 3. Generator “stator” winding. 4. Central gear of the differential.5. Link. 6. Satellites. 7. Second central gear. 8. Driven shaft.

Engine shaft 1 rotates generator rotor 2 and link 5 of the differential. Satellites 6, which are loosely placed on the cage but interconnected, are rolled along central wheels 4 and 7. “Stator” 3 which is located on the same axle as the rotor and connected with the central gear wheel 4, may rotate in both

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directions. Generator rotor and stator comprise a "double rotation" electric machine. Central wheel 7 is connected with driven shaft 8. When drive 1 is rotated by the engine, generator rotor 2 and link 5 also rotate. If driven shaft 8 is loaded, and a certain ratio of differential gear pairs is maintained, it will rotate in the same direction with engine drive 1 and link 5. Then central gear wheel 4 and generator stator 3 will try to rotate in the opposite direction. With an electrical load present in the generator circuit, the cage will be dragged after the generator rotor, as it is realized in an electro inductive coupling, with the force proportional to this electrical load, and will partly lock out the differential, which will lead to the rotation of the latter around its axle following the generator rotor, pinions' rolling along the central wheels will slow down, the driven shaft will rotate faster, the torque will decrease. The driven shaft's resistance force will increase the sliding between the rotor and the stator which will decelerate the driven shaft. At the same time, as the driven shaft decelerates, the pinions' rolling along the central differential gears will increase, the torque of the driven shaft will grow up to the value determined by the ratio of the size of gears and pinions. When the forces are balanced, the rotation speed is established, corresponding to the required torque value. When the engine power is increased or decreased, the established speed value and torque of the driven shaft is increased or decreased. When power required for motion is increased or decreased, the speed is increased or decreased proportionally, the driven shaft torque is increased or decreased. Without sliding between rotor and stator, engine shaft and driven shaft rpm would be the same, the transmission gear ratio would be equal to 1, the torque would be equal to the engine torque. When the driven shaft is loaded to the maximum, the speed is lowest, while the torque is highest, determined by the ratio of the sizes of differential gears. You can also set the optimum torque value for the generator drive by adjusting the ratio of the sizes of gears of the differential pair connected to the stator.

COUPLING MECHANISM

The torque of the driving shaft of a modern vehicle is provided by a gearbox, and the torque of the low gear is approximately 4-5 times higher than the torque of the top gear. This ratio ensures acceleration and movement of the vehicle throughout the whole speed range. The most difficult in terms of torque is the first part of acceleration from the start. The low gear is aimed at increasing the torque as much as possible, mainly in order to start the movement. This maximum torque mode is barely used afterwards. Gearbox construction may be simplified by changing the clutch mechanism [3]. The friction coupling may be included into locking of the planetary differential , as it has been proposed in the previous diagram in the Figure 1. An example is shown in Figure 2 inclusion

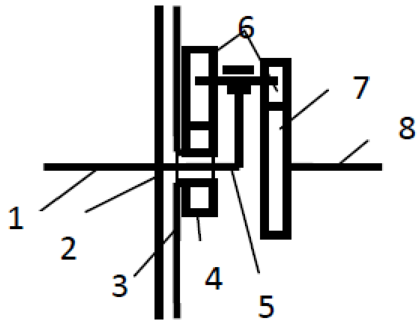

Figure 2

1. Drive shaft from gearbox. 2. Load-bearing slip coupling disc.3. Mating disc of the coupling. 4. Central gear of the differential. 5. Link. 6. Satellites. 7. Second central gear. 8. Driven shaft.

Engine shaft 1 rotates the disc of the frictional (or any other) load-bearing slip coupling 2 and link 5 of the differential. Satellites 6, which are loosely placed on the cage but interconnected, are rolled along central wheels 4 and 7. Mating disc of the coupling 3 is connected with central gear wheel 4. Central wheel 7 is connected with driven shaft 8. When drive shaft 1 rotates, coupling disc 2 and link 5 rotate as well. If driven shaft 8 is loaded, it will rotate in the same direction with engine drive 1 and link 5. Then central gear wheel 4 and mating disc of the load-bearing slip coupling 3 will lock the differential, thus decreasing the transmission ratio of the mechanism. As long as there is slippage in the coupling, the torque will increase at the driven shaft, because part of the engine power will not be transmitted through the coupling, but through the gear pairs of the differential. At the same time, the torque will depend on the selected parameters of the gear pairs. In this case, the coupling will only lock the differential. When locked completely, the torque at the driven shaft will be the same as that at the drive shaft of the mechanism. It will probably be suitable to take 2 as the value of torque increasing. Then the torque will increase in 8-10 times at the start of the vehicle at low gear, which is not necessary, so we can decrease the maximum transmission ratio in the "generator-differential" mechanism. This clutch gear may also be used in non-hybrid vehicles. This will render low gear unnecessary, and the released range of transmission ratio change may be transferred to higher values. The starting and the acceleration will be realized more smoothly and with less strain for the clutch gear, than usual, because it will only bear the part of the load which is included in the controlling arm of the differential. This clutch gear will provide torque increase, as well as transmission ratio increase. This will facilitate clutch gear operation and engine work at the starting stage.

THE ELECTRIC MOTOR WITH A DIFFERENTIAL

A hybrid drive is often used for switching on actuating electric motors which are directly connected with free driving wheels. There is an issue of coordinating electric motor revolutions, which are often nearly constant for optimum operating modes, with wheel revolutions changing in a wide range from zero to values corresponding to the maximum movement speed. Besides, it is hard to apply economically sound types of electric motors, because economical asynchronous electric motors have a low starting torque, and the most economical synchronous motors have no starting torque at all. But when you include the differential into the electric motor construction, as it is shown by the diagram, its rotor revolutions will be close to optimum from the very start, and they will change in a wide range at its shaft. This will be performed without power loss and without peak current loadings, at the optimum operating mode. The main advantage of such electric motor is multiple torque increase at its shaft during high loads, with low rotational speeds of electric motor shaft. There are no start-controlling devices that would increase start torque, and with a direst start, when the current is increased in 8-10 times, the torque is only increased in 1.4 times. This is accompanied by overheating of the windings, destruction of bearings. On the Figure 3 shows the structure of the electric motor with a differential mechanism, which provides for multiple torque increase at the shaft when the load is increased. It can be of any type, including synchronous. At the same time, the torque at the shaft will increase multiple times when the load is high, shaft revolutions will decrease proportionally, electric motor spindle torque will remain optimum for this construction when operating at optimum revolutions [4]. Thus, every electric motor has a sort of a continuously variable automatic transmission.

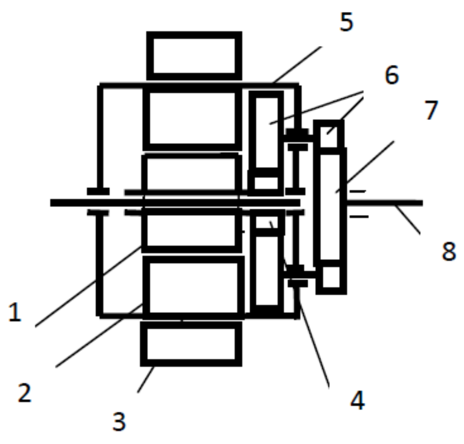

Figure3.

1. Inner rotor 2. Electric motor rotor winding 3. Stator winding 4. Central wheel. 5. Link 6. Satellites 7. Second central wheel 8. Driven shaft.

Inside electric motor spindle 2 there is a common axle holding inner rotor 1, which is inductively connected with rotor 2, the two making an electro inductive coupling, rotor 1 is also connected with central wheel of the differential 4. Electric motor spindle 2 is mounted on link 5, which holds satellites 6, loosely placed on the cage but interconnected, which are rotated along central wheels 4 and 7. Central wheel 7 is connected with driven shaft 8. Electric motor spindle 2, interacting with stator 3 windings, rotates at the established optimum speed, turning link 5 of the differential. Central wheels 4 and 7 should rotate in opposite directions when the cage is rotating: Wheel 7 rotates in the same direction, as the rotor and cage, wheel 4 - in the opposite direction. But, wheel 4 is connected with inner rotor 1, which is dragged after rotor 2 by electro inductive force, partially locking the differential, decreasing its transmission ratio. When resistance force at the driven shaft is increased, central wheel 7 is decelerated more, the slippage between rotors is increased, the transmission ratio is increased, the pinions are turning around the central wheels to a larger extent, the rotational speed of central wheel 7 is decreased, and the torque of the driven shaft is increased. The inner rotor, in case of sufficient decelerating load at the driven shaft, can decrease rotation up to the full stop in relation to the frame, and even start rotating in the opposite direction. At this moment, there will be maximum torque at the driven shaft. When required torque at the driven shaft is decreased, its revolutions increase, the slippage between rotors decreases, the rotational speed of the driven shaft increases, while the torque decreases proportionally. When the vehicle is started, wheel revolutions, as well as revolutions of the electric motor shaft connected to it, are equal to zero, but there will be no "short circuit", as it happens when electric motors are operated. There will be no peak loads and power losses. Electric motor spindle will rotate, and the inner rotor will rotate in the opposite direction, creating maximum torque at the electric motor shaft, for the given transmission values of the differential. The transmission values of gear pairs of the differential should be selected so that in case of balance of forces the torque at the driven shaft is significantly higher than that at the inner rotor. Transmission reproduced, it functions as a visual working model that is shown in Figure 4

Figure4.

The constructions with such differential, so-called "mechanism of David", have been selected as an example. Theoretically, power train may be constructed with any gear transmission or transmission of any other type.

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Ravil Khadeev, was born on January 1, 1945. Until 1993 was a military a fighter pilot, PhD, graduated from the University of specialty - theoretical physics. He worked in the Scientific Research Testing Institute of Military Medicine of the Russian Federation, he is now working in a private company chief technologist for the production of composite materials.