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HYBRID DRIVE GROUP

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Abstract

In this paper we present a laboratory stand solution with a hybrid propulsion group. It contains a thermal engine, a mono-cylinder in four times, and as an electrical motor a synchronous machine with permanent magnets.

We present the coupling solution between the two power sources, the block electrical scheme, the functioning and the possibilities of the stand.

1.INTRODUCTION

The mankind policy is subordinated, in a large measure, to the energetic resources. The oil has the major role in this equation. After the invention of the motors with internal combustion, the oil becomes the main energetically resources, having real advantages as the caloric power, the physique volume, transport facilities and storage [1].

Taking into account the pollution generated by the combustion of the oil products, the limited reserves and the emphasizing of the worldwide crisis generated by this, there are some clues that the oil era end is close.

For this reason the car manufactures treats more seriously the possible versions of replacing the usual fuels: the gas and the diesel oil. It is true that the storage batteries are not yet, a serious rival for the fuel tank. Fuel cells, a possible substitute for them, make greater and greater progresses, but it takes about 10-15 years to a serial production.

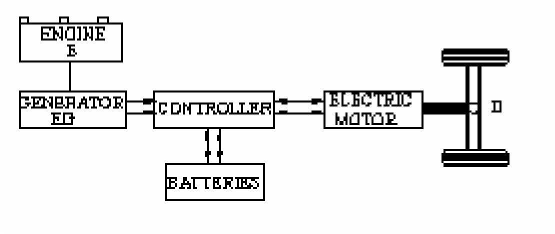
So there is a possible replacement of the thermal engine with an electric one or a possible coexistence of both.

Nowadays the hybrid vehicles start to reach the market, showing the first example of a modification of propulsion concept and preparing of some serial pure electrical versions.

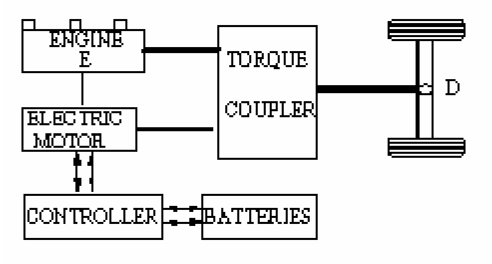
The usage of the electric motors in cars propulsion systems can be compared with the usage of the electronics in this field. In the first stage electronics didn't modified the structural conception of the system. Then, because of the electronic components reliability growth, because of their prices and because of the hardening of the laws regarding the pollution and fuels consumption, the car electronics became indispensable. It determined a reevaluation of the mechanical part, a development of the cars mechatronics, to a mechanical part designed for implementing the electronics circuits, including the programmable ones.

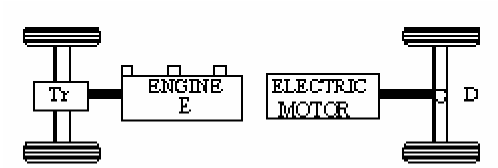
The acceptance of the electric motor in propulsion systems breaks down the monopoly of the thermic engine in car traction. These acceptance was performed even with the condition that his weight to mass ratio reached. the 1,6 KW/Kg, with a gauge less then that of the thermal engine.

Coupling between the thermal engine and electric motor to obtain the set propulsion version creates some problems. They are referred to the adopted version (Fig. 1)



a. Serial hybrid propulsion





b. Parallel hybrid propulsion c.Dual system

Fig.1. Hybrid traction solutions

In Fig.1 a serial version that suites well the high power cars for which the gear box will be too big. The conversion of the chemical energy in mechanical energy (in the thermal engine) and then in electrical energy (in the electric generator) an then again in mechanical energy necessary for the propulsion (in the electrical motor) leads to a low efficiency. From a mechanical point of view there are not any problems.

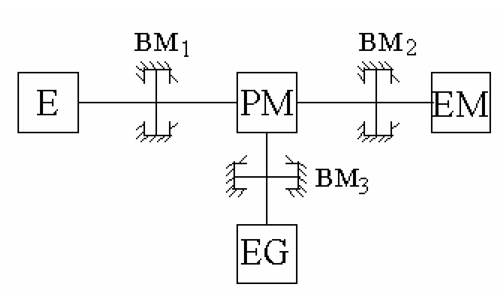
In Fig.1b there is a parallel hybrid version. The coupling between the two power sources has to allow: only an electric functioning; only an termic functioning; combined functioning (thermic+electric); energy recovering from braking.

A much simpler hybrid traction version is the dual one (Fig.1c) in which every power source acts on a bridge.

In [2] are analyzed two coupling solutions of those two engines: thermal and electric.

2. SELECTION THE HYBRID SOLUTION

In Fig.2 [2,3] the solution adopted in the laboratory for Electric and Electronic Car Equipment from Univ of Piteşti is presented.



a) Mechanical diagramm

b) Stand general overview, mechanical part

Fig.2. Hybrid drive stand

- A
- thermal engine (*E*)
- an electric motor (*EM*)
- an electric generator (*EG*)
- a planetary mechanism (*PG*)
- three blocking systems ($BM_{1,2,3}$).

The solution was chosen such as the stand has to be multifunctional .
A first aspect that was followed is that of determining each parameter of the driving system components.
Determining the characteristics of the thermal engine, and first of all of the complex characteristics, the active torque as function of speed that was superposed on the specific consumption curves, supposed using a brake and a adequate mechanical system for torque, speed and full consumption.
This stand allows the following tests: the torque from *E* is transmitted to the electric generator that works as a brake, by the mechanism *PG* with BM_2 blocked.
A torque transducer fixed on the generator shaft *EG* allows reading the values of the torque developed by *E*. A tachogenerator fixed on the shaft of the thermal engine allows having the speed of *E*. The measurements are performed in a steady state regime, measuring a medium fuel consumption.
The aim of those determinations is to obtain the best functioning points of *E*.
The electrical motor is a synchronous motor with permanent magnets, for which the speed and the active torque can be programmed.
If we use an electric motor with unknown characteristics, because of the stand symmetry, they could be determined, in the same way as before, using an adequate speed measuring system.
To use only one torque transducer is very important that one of those torques (of *E* and *EM*) to be know, for a hybrid propulsion.
A second aspect is that of the hybrid functioning system: the simultaneously functioning of motor *E* and motor *EM*. The main element of the driving system is represented by the *PM* mechanism.
The *PM* mechanism is a symmetric simple differential with cylidrical wheels which has the following relation between the angular velocities:

$$\omega_0 = \frac{\omega_E + \omega_{EM}}{2} \qquad (1)$$

where: $\omega_2 = \omega_E$, $\omega_5 = \omega_{EM}$,
where: ω_0 - the angular velocity at the output of *PM;*
ω_E - the angular velocity of the thermic engine shaft *E;*
ω_{EM} - the angular velocity of the electric motor *EM* shaft.
The motor *E* acts pinion 2 , and the motor *EM* pinion 5. The output from *PM* is at the carcasse of the planetary mechanism *PM*.

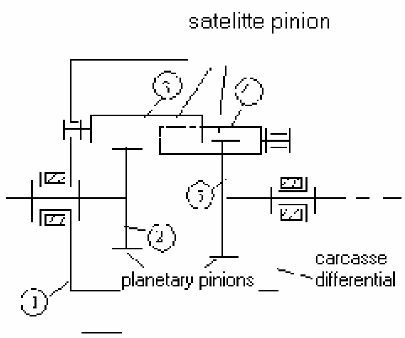


Fig. 3. The PM mechanism

3.THE OPERATING SCHEME

The command block diagramm (fig.4) includes the following control units: a master unit (UCE_1) and two units for those two motors (UCE_2, UCE_3).

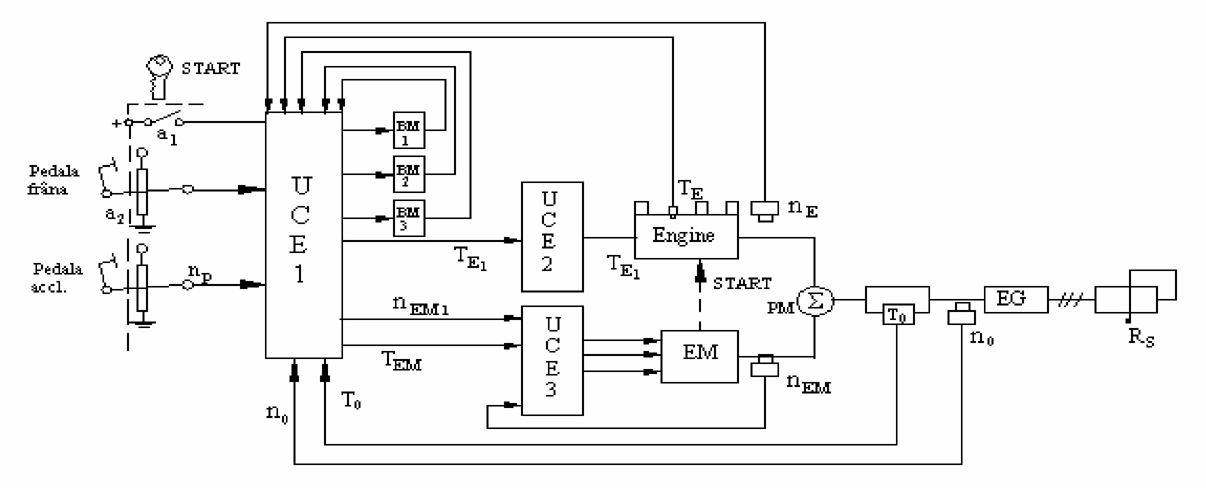


Fig.4. Control block diagramm of a hybrid stand

The unit 1 has the role of the stand control that receives the commands inputs of the master (start-up, speed, braking) and the main entities from the process, torque T_0 and the speed n_0 at the output of the shaft of the driving system. As a function of n_0 and T_0, using the motor characteristics and the operating regime, the commands UCE_2 or UCE_3.

Unit 2 has the role to act the acceleration pedal *E*, by selecting only the best positions..

Unit 3 has the role to act *EM*, setting the speed n_{EM_1}, the necessary toque T_{EM} and the acceleration.

The scheme assures operating in the following regime:

- start-p (START)
- only electrical operating
- only thermical operating
- hybrid operating
- acceleration, decceleration

The functioning logics doesn't allow the thermic engine operating at partial loads.

The start-p s performed electrically with EM.At a certain speed the thermic engine will be started. In the hybrid regime the main motor is E, the electric one EM contributes to the increasing of the torque, when is necessary, or to the loading of the thermic engine to reach it to the best parameteres.

4. REFERENCES

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