THE USE OF THE DC MOTOR IN THE ACTUATION ELECTRIC OF A CAR

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Abstract: This paper studies aspects of using DC electric drives in vehicles. It summarizes the main characteristics of the DC motor, the constructive variants, the advantages it presents in relation to the asynchronous motor. The paper also outlines an example of equipping a car with electric drive, that would correspond as much as possible to the current requirements both regarding the environment and the economic and social one.

Key words: *DC motor, adjustable drive, electric car*.

1. INTRODUCTION

Human being was always in need to move around. Starting from the prehistoric times, man discovered bipedal walking, and over history he researched, discovered and experienced more and efficient ways of transportation. In modern times, internal combustion engines represented the main drive principle used for land transportation.

While realizing that use fossil fuels in internal combustion engines are harmful to environment and the reserves of fossil fuels needed to run cars are dwindling, a new solution expanded rapidly around the world: electric cars that use energy produced by renewable sources.

In this paper we're going to study electric-powered cars, particulary using the D.C motor.

2. CONSTRUCTION AND PRINCIPLE OF OPERATION OF THE DC MOTOR

The foundations of DC motors were laid by William Ritchie and Hippolyte Pixii in 1832. Like any rotary electric machine, the DC motor (figure 1) consists of two armatures, the stator and the rotor [4], [1].

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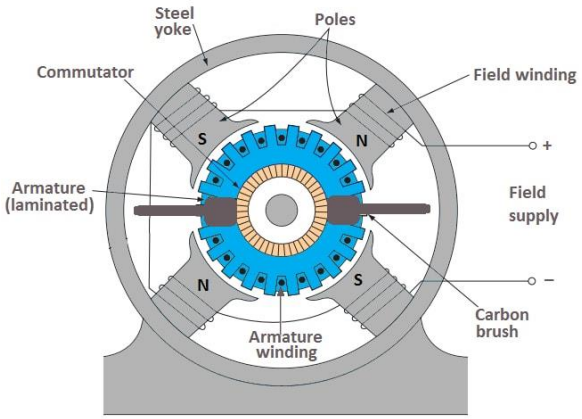

Fig.1. Cross-section through the DC machine with main pole detail

The stator is the fixed part formed by the stator yoke, the main poles, which carry the excitation winding, the auxiliary poles, the side shields, which support the bearings with bearings or slides, as well as the system of brushes and brush holders. *The rotor* is the mobile part of the machine, made up of a package of tubes with notches on the outside that support a direct current induced type winding. The tole pack is fixed on the machine shaft like the collector and rotates with it.

3. OPERATING EQUATIONS

Considering the DC motor with separate excitation connected to a constant voltage network (U), the equations are obtained [4], [10]:

$$U = E + R \cdot I + \Delta U_p \tag{1}$$

$$E = k_e \cdot n \cdot \emptyset \tag{2}$$

$$\emptyset = \emptyset(I_{ex}, I) \tag{3}$$

$$M = \frac{k_e}{2\pi} \cdot \emptyset \cdot I = k_m \cdot \emptyset \cdot I \tag{4}$$

4. DESIGN PRINCIPLES

Computer-aided design systemis used for modeling parts, assemblies and for making technical drawings [6], [7].

The design is based on the generation of solid entities that are created with the help of construction entities such as two-dimensional profiles, but also of additional elements, such as surfaces, intersection curves, projection curves, intersection points or geometric constructions [6], [7], [9].

As can be seen in figure 2, the base of the chassis has a symmetrical shape, as well as the covers related to the two engines.

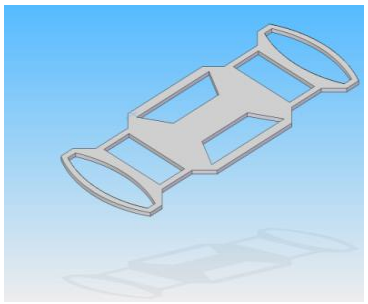

Fig.2. Chassis of the designed vehicle

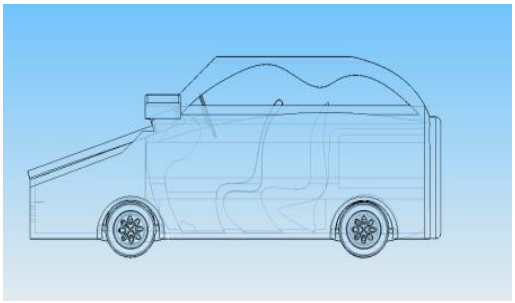

Fig.3. Longitudinal section of the whole car

Figure 3 shows a longitudinal section of the entire vehicle through which you can see both the interior and its functionality [12].

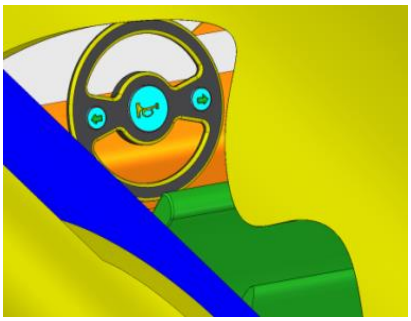

Fig.4. Steering wheel

The seats have an ergonomic shape, are made of very light materials, have in their composition a material that takes the form of the passenger who sits in it and returns to its original shape with its release.

Wheels are a core component of any car. They are made of an aluminum alloys, low in weight, with good resistance to mechanical shocks. Tubeless tires ensures necessary grip inoperation.

The steering wheel (figure 4) accomodates basic functions, including signaling of change of travel direction, as well as the command of audible warning feature in case of danger (i.e. control of the horn).

5. ELECTRICAL PART AND SIMULATION

AutoCAD Electrical software can be used to design the electrical diagram on the basis of which the electric car operates (figure 5) [11].

5.1. The principle of operation of the prototype

In the figure 5 is shown the detailed call that includes the measuring instruments [5], [8] for the parameters of each main component: V_1 , A_1 - voltmeter, ammeter for battery batteries; V_2 , A_2 – voltmeter, ammeter for the DC motor that sets the car in motion; V_3 , A_3 - voltmeter, ammeter for "secondary generator"; K - regulates the supply voltage to the dc motor; AUX - the other consumers such as the lighting system, the audio system, the navigation system, the cooling system of the passenger compartment.

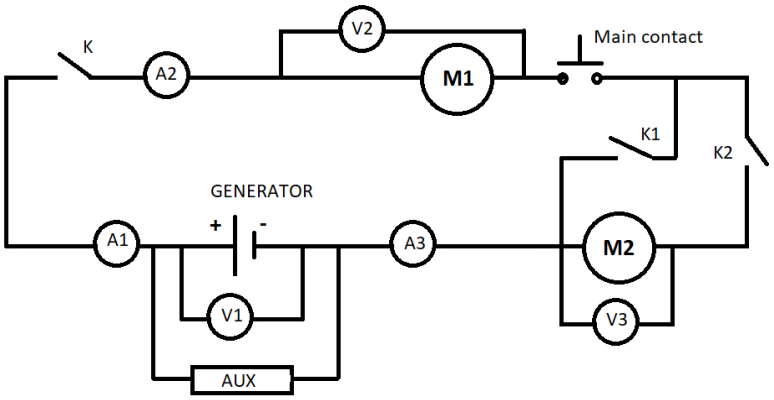

Fig.5. Detailed diagram of the designed electric vehicle

5.2. Simulation of the start-up mode of the DC motor used in the drive of the motor

A direct current motor whose initial technical data is as follows will be considered: power - 22 kW, nominal voltage - 240 V, electromagnetic field voltage - 300 V, rotational speed - 1750 rpm.

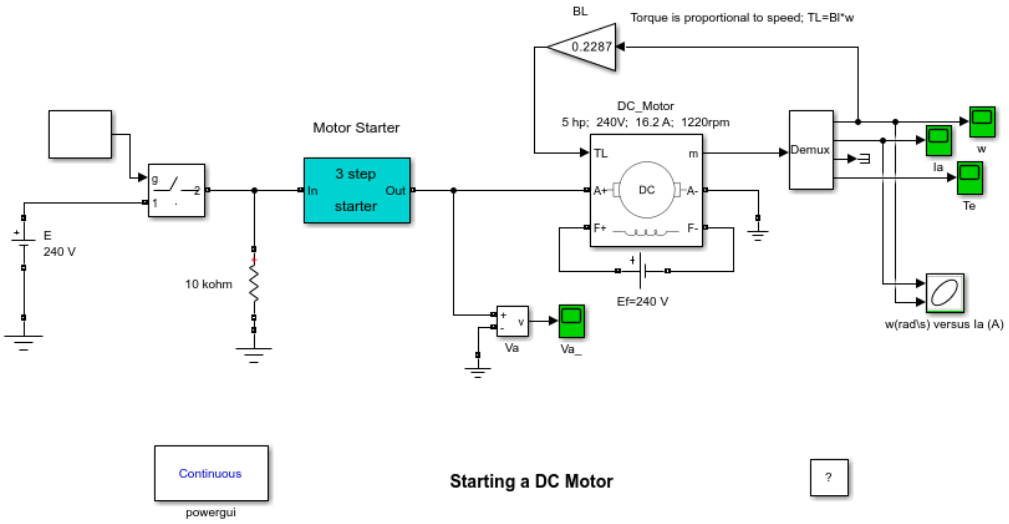

Fig.6. Starting DC Motor scheme

Using the simulation scheme presented in figure 6, the information resulting from the process will be displayed on the devices called "sinks", respectively w, Ia, Va and Te, with the specific indications of the quantities: rotation speed, current, voltage, electromechanical torque of the DC motor [2],[3].

Following the simulation, the following values were obtained:

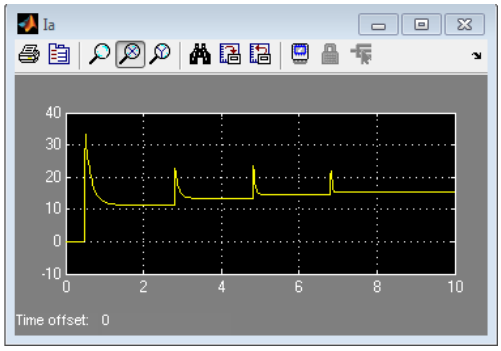

Fig.7. Current diagram

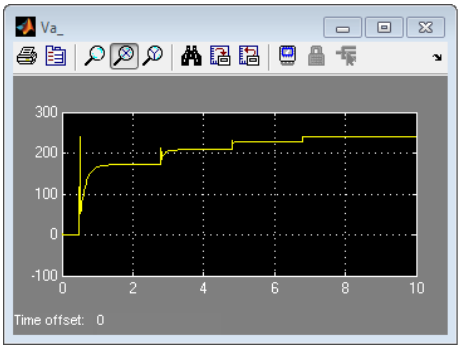

Fig.8. Voltage diagram

The reference speed change rate closely follows the acceleration and deceleration values to avoid sudden reference changes that could cause overcurrent in the armature and destabilize the entire system. The current regulatory controls the current in the armature by calculating the appropriate control angle of the thyristors. This generates the output voltage required by the rectifier to obtain the desired current through the armature.

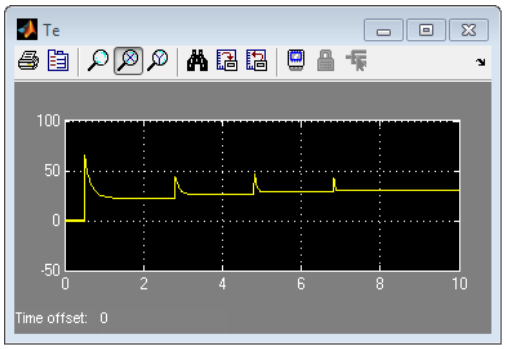

Fig.9. Electromechanical torque

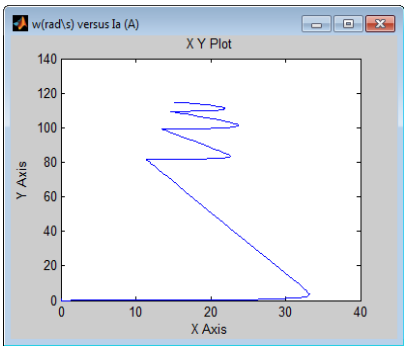

Fig.10. Variation of the speed

6. CONCLUSIONS

Following the analysis of the construction, as well as of the specific phenomena of operation underload provided by available sources of information, we came to the conclusion that although the DC motors have a relatively simple construction, a control circuit that does not require many components, yet they are outperformed by little by the AC motors.

Of all the models of electric motors that operate in direct current, the one that is best suited to propelling a car is the one with series excitation, because:

- it has a soft mechanical characteristic, at which the speed varies within wide limits depending on the torque.

- the power taken by themotor from the power supply is approximately equal to the electromagnetic power,
- at low values of the load torque, the speed can increase, and the danger of its mechanical damage may appear. For this reason, it should not be allowed to run idle, instead it must be rigidly coupled with the load mechanism.

In the near future, the manufacturing technologies of the motor will have to be improved, for a higher efficiency, better cooling and more affordable cost. Regarding the batteries, without which the electric car cannot function, it is necessary to consider the highest possible capacity for storing electricity, to occupy as little volume as possible and, implicitly, to have a reduced mass. All these aspects apply also to the chassis, body parts, interior compartment, as they directly influence the travel autonomy, as well as the safety of the users of the electric car.

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