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A UNIT TO RECOVER ENERGY FROM A DRIVER'S SEAT VIBRATION IN A MOTOR VEHICLE

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Abstract

Combustion engines drive motor vehicles, which are commonly used, and their efficiency does not exceed forty per cent. It is hard to accept such a waste of energy nowadays when there is less and less fossil fuel and the ecological norms are being tightened. That is why hybrid power transmission systems and systems for energy recuperation – especially kinetic, so far being lost – are becoming more popular. One of such solutions is a unit to recover energy from a driver's seat vibration in a motor vehicle. It allows changing the kinetic energy of the vibrating seat into the electric one. Such a unit is installed under the driver's seat and supports the gaseous shock absorber. The unit consists of two toothed bars, coupled by two pairs of gear wheels, which drive the alternating current generator rotor. The rotor is joined with a driving shaft by one-way centrifugal clutches. One bar drives the rotor while the seat moves down and the other - while the seat moves up. The rotor is equipped with permanent magnets, which, by rotation, induce the power in the stator's winding. The generated power goes through the voltage stabilizing and rectification systems (4.75–5.25 V) and charges four batteries connected to USB output. The obtained electric energy may be used to supply other electronic devices, e.g. mobile phones. The unit will be installed in a farm tractor. The research checking the unit's effectiveness will be carried out in the near future.

Keywords: *energy recuperation, energy recovery, vibration energy, motor vehicle, driver's seat*

1. Introduction

Motor vehicles, which are commonly used, are driven by combustion engines and their efficiency does not exceed forty per cent. It is hard to accept such a waste of energy nowadays when there is less and less fossil fuel and the ecological norms are being tightened [3]. That is why hybrid power transmission systems and systems for energy recuperation – especially kinetic, so far being lost – are becoming more popular [4].

2. Systems for energy recovery in a motor vehicle

In order to improve the efficiency of the motor vehicle's power transmission system, there are many ways of recovering energy, especially kinetic – which is lost in suspension system and braking system of a vehicle. The ways to recover energy are, among others: a system to recover energy from braking, including KERS, i-ELOOP system – a system to recover energy from shock absorber motion or a system using pneumatic accumulator.

In case of recovering the energy from braking, the kinetic energy of a vehicle in motion is changed into electric energy, which is stored in accumulators. The change is done with the usage of a generator and thank to it the stored energy can be used to assist the power transmission system, e.g. during the acceleration, with an additional torque in the hybrid system as an electric motor.

KERS system (Kinetic Energy Recovery System) accumulates the kinetic energy, which in usual conditions is lost during the braking process, stores it and gives back as an additional

moment during the acceleration process [7]. There are three types of systems used: electric, mechanical and hydraulic. The electric system (the most popular) uses a generator connected to the power transmission system, which changes mechanical energy into electric one and vice-versa. During the recovery the obtained energy is accumulated in a battery. The mechanical system is based on a flywheel, which is driven during the braking process. The flywheel is usually made of carbon fibres and its speed of rotation comes up to 80000 rotations per minute. The hydraulic system uses the braking energy to increase the parameters of the factor [6].

The i-ELOOP system (Intelligent Energy Loop) of Mazda uses a huge capacitor to store the energy. The capacitor can be charged and discharged very quickly and is very durable [5]. The capacitor is charged during the retrofire. The accumulated energy is supposed to charge electric devices in the vehicle. A modified alternator is used as a generator. The whole system consists of an alternator with a variable current 12–25V, low-resistant, double laminar electric capacitor and a voltage converter. The system starts to recover the energy already at the moment of accelerator release and the vehicle slows down. Then the alternator charges the capacitor with the voltage of 25V. Next, the electric energy from the capacitor is transmitted through a voltage converter to the devices in the vehicle. The system may also charge the battery [2].

Oil shock absorber is replaced by electric system in the system for recovering energy from the motion of the elements of the vehicle's suspension. Mechanical energy is changed into electric one by linear generator, which works differently than a linear induction motor. The obtained energy may be used for charging the battery. Such technology was invented and patent at the Tufts University in Boston. A licence to use this technology was given to LLC company. The inventors claim that four shock absorbers can generate the power of 2–17 kW. The amount of the recovered energy depends on the vehicles size and road conditions [1].

A system which uses a pneumatic battery to recover kinetic energy from a vehicle driven by a combustion engine works completely different. Such battery is connected with the exhaust by lines and valves unit. During the braking process the petrol inflow is cut off and the motor, driven by inertial force, works as a piston compressor. The exhaust and some additional installations lead the compressed air to pneumatic battery. When a vehicle accelerates, the air from the pneumatic battery is led into engine, which increases its horsepower. The system is meant for the vehicles driven by Diesel engines, especially the ones used in the city (a lot of starts and stops).

The systems mentioned above greatly interfere in the power transmission system – they strongly complicate the construction and increase the possibility of damages. This fact also increases the price of a vehicle. Although a huge amount of energy is saved, the usage of those systems may turn out to be uneconomic for an average driver.

3. A unit to recover energy from a driver's seat vibration in a motor vehicle

A unit to recover energy from a driver's seat vibration in a motor vehicle does not interfere in any of the elements of the power transmission system of a vehicle. That is why it does not influence its reliability. This unit allows changing the kinetic energy of a vibrating seat into electric one. The unit is installed under the driver's seat and supports the gaseous shock absorber. The unit consists of two toothed bars, two pairs of gear wheels, two coupling units and an a.c. generator (Fig. 1). All the elements (apart from toothed bars) are installed in one housing, which is fixed to the seat with four screws. The toothed bars, in turn, are connected with the seat and move vertically. The maximum seat stroke is 100mm. The bars drive the gear wheels, which in turn give the rotation moment to coupling units. The coupling units function as one-way centrifugal clutches and one unit transmits the rotation moment left – ands the other – right in order to ensure one way of generator rotor rotations. When the seat goes down the working motion is done by one bar, one pair of gear wheels and one coupling unit. The other bar makes dead movement because the other coupling unit does not mesh with the rotor. While the seat goes up the situation is converted i.e.: the rotor is driven by the other toothed bar. The rotor is equipped with permanent magnets which,

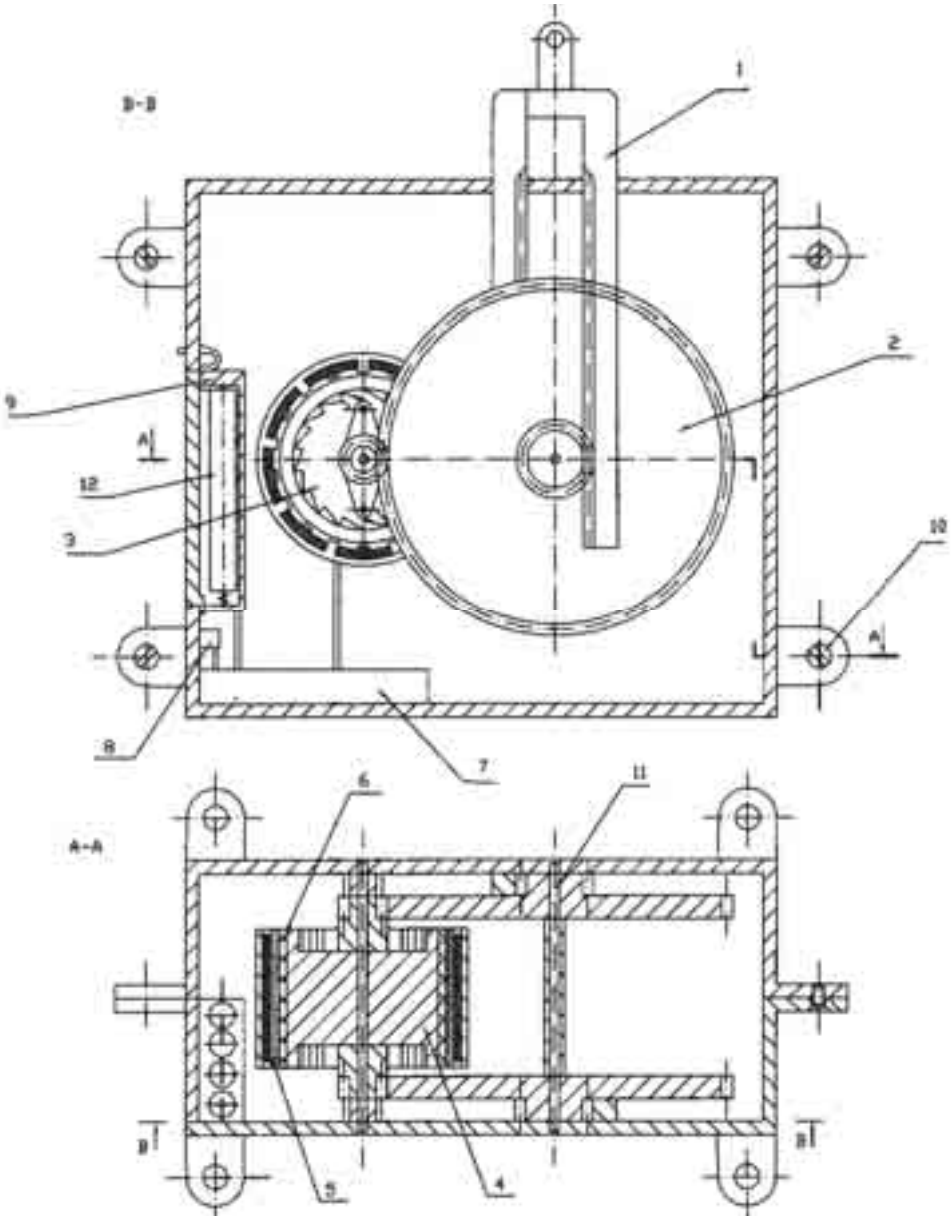

Fig. 1. A unit to recover energy from a driver's seat vibration in a motor vehicle: 1 – toothed bars, 2 – gear wheel of a coupling unit, 3 – one-way centrifugal clutches, 4 – rotor, 5 – stator, 6 – permanent magnets, 7 – voltage stabilizing and rectification system,8 –USB output, 9 – batteries holder, 10 – fixing arms, 11 – hgear wheels' axis, 12 – batteries

by rotation, induce the power in the stator's winding. The generated power goes through the voltage stabilizing and rectification systems (4.75–5.25 V) and charges four batteries. A USB output is connected to the batteries. The electric systems consist of a.c. generator, Graetz bridge, four Schottky diodes, the LM317T adjustable stabilizer, three electrolytic capacitors, non-polarized capacitor, three diodes, three resistors, LED diode, four 1.2 V batteries and a USB socket. The gear wheels of the unit and the generator's rotor are attached on two fixed axles set in the housing. They are attached by a slide bearing. The axles are made of steel, whereas the gear wheels, coupling units and the housing are made of plastics (boracetal – commercial name). A MOLYKOTE PG-30L grease was used in order to decrease friction.

The obtained electric energy may be used to supply other electronic devices, e.g. mobiles or' when using other electronic system, for charging the capacitors adjusted to be charged and discharged quite quickly. Such capacitors are very good when there is a short impulse of a great power needed, separated by longer periods of lower power [5].

4. Conclusions

A unit to recover energy from a driver's seat vibration in a motor vehicle presented above requires carrying out a research to estimate its usefulness. Because of the specific construction the best vehicles for such a unit seem to be farm tractors using the side roads. That is why the researched unit will be installed on a farm tractor. A research checking the unit's effectiveness will be carried out in the near future.

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