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ELEMENTS OF THE THEORY OF FORCE LOADING BY THE TORQUE MOMENT OF THE VEHICLE WHEEL BY THE JET MAIL IN THE ZONE OF ITS CONTACT WITH THE SUPPORT SURFACE

When the work process is carried out by the wheel mover, it is loaded by the force of gravity, which leads to deformation of the tire. The article deals with research issues of the automobile system in the transmission of which an elastic shock is provided with the use of a resonator nozzle. To develop the elements of the theory, the theorem on the change of kinetic energy in the proposed automobile system, as well as the Lagrange equation of the second kind, was applied.

The purpose of the study is to create a circuit for the transmission of an elastic impulse, which allows the wheel drive to provide rotary motion through the accumulated spring-reactive energy balance, which is a factor in the latest technology of moving the automotive system.

The scientific direction of the article is that the proposed design of the automobile system in which the rotation of the wheel drive uses the energy of an elastic shock without a transmission, which increases the torque on the wheel drive.

The methodology of the study is to establish a theoretical connection between the force created by the "jet thrust" and the increase in the dynamics of the automotive system.

The result of the research is the theoretical creation of a car design with a moving platform using damping elements in the car system, which allows creating "physical discomfort of the support surface". To describe and reveal the concept of "physical discomfort of a support surface", we used the theory of differential equations that confirm the existence of such a surface under certain conditions of car operation.

The value of the presented research material, as well as the results of the work performed, will allow to make a contribution to the automotive industry.

The proposed structural development of the car is suitable for use in order to increase the traction capabilities of the vehicle.

Key words: *physical-mathematical model, driver, wheel, wheel-elastic compensator.*

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ЕЛЕМЕНТИ ТЕОРІЇ СИЛОВОГО НАВАНТАЖЕННЯ КРУТНИМ МОМЕНТОМ КОЛЕСА АВТОМОБІЛЯ РЕАКТИВНИМ ПОШТОВХОМ В ЗОНІ КОНТАКТУ ЙОГО З ОПОРНОЮ ПОВЕРХНЕЮ

При виконанні робочого процесу колісним рушієм він навантажується силою ваги, що приводить до деформації шини. В статті розглянуті питання дослідження автомобільної системи в трансмісії якої передбачено пружний поштовх з застосуванням резонаторної насадки. Для розробки елементів теорії було застосовано теорему, щодо зміни кінетичної енергії в запропонованій автомобільній системі, а також рівняння Лагранжа другого роду.

Метою дослідження є створення схеми підведення пружного поштовху трансмісії, що дозволяє колісному рушію забезпечити обертальний рух шляхом накопиченого пружинно-реактивного енергетичного балансу, який є фактором в новітній технології переміщення автомобільної системи.

Науковий напрям статті полягає в тому, що запропонована конструкція автомобільної системи в якій обертання колісного рушія використовує енергію пружного без трансмісійного поштовху, який підвищує крутний момент на колісному рушії.

Методологією дослідження є встановлення теоретичного зв'язку між силою, яку створює «реактивний поштовх», з підвищенням динаміки автомобільної системи.

Результатом дослідження є теоретичне створення конструкції автомобіля з рухливою платформою з використанням елементів демпфування в автомобільній системі, що дозволяє створити «фізичний дискомфорт опорної поверхні». Для опису та розкриття поняття «фізичний дискомфорт опорної поверхні» нами використано теорію диференційних рівнянь які підтверджують існування такої поверхні в певних умовах експлуатації автомобіля.

Цінність викладеного матеріалу дослідження, а також результати виконаної роботи дозволять зробити внесок в галузь автомобільного виробництва.

Запропонована конструктивна розробка автомобіля придатна для використання з метою підвищення тягових можливостей транспортного засобу.

Ключові слова: *фізико-математична модель, рушій, колесо, колісно-пружний компенсатор.*

Statement of the problem

One of the directions of development of structurally finished motor vehicles are those consisting of several chains interconnected by various devices. Such chains are parts of specialized rolling stock (SRS), in which a personal trajectory of movement is applied and can be active or passive.

As a direction of SRS development, SRS with active, passive and combined drive can be proposed, which are respectively presented in fig. 1.

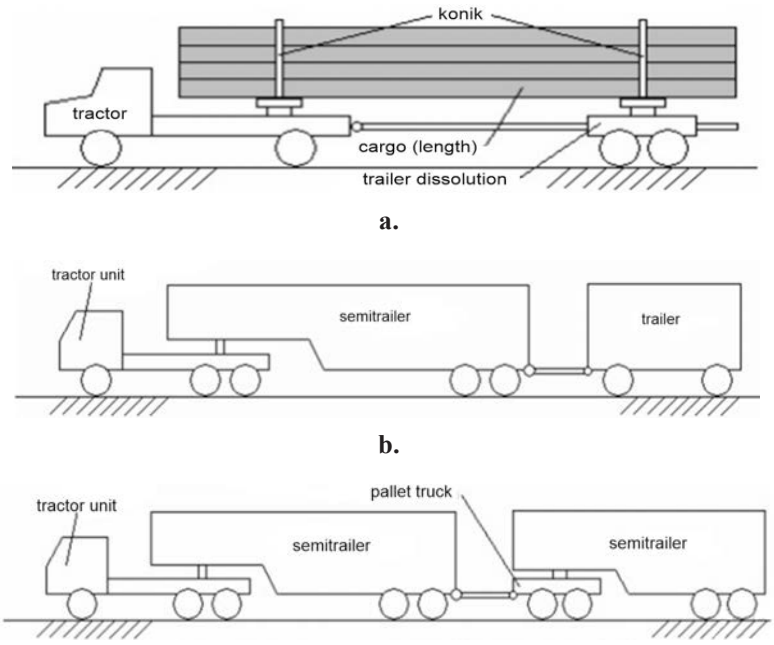


Fig. 1. Schemes of trucks: a – SRS with active drive; b – SRS with passive drive; c – SRS with combined drive

Analysis of recent research and publications

The transmission consists of a clutch, gearbox, driveshaft, final drive and rear wheel drive shafts. To transmit the torque generated by the engine to the drive wheels, all components of the transmission must work in perfect harmony. For this purpose, they are connected to each other by a system of joints, shafts and gears. In a Mercedes mobile vehicle [1], the engine develops sufficient power within a narrow crankshaft speed range. In order for the Mercedes to develop the required tractive force, a gearbox with different magnetic ratios is provided.

Deutz – Fahr tractors feature the new Sense-Shift transmission, which is fitted to the 6 Series tractors – a huge step forward in terms of driving comfort and performance. From the gearbox to the gear lever, the shift system has been redesigned for quick and easy gear changes. But the real breakthrough is that with the Sense-Shift transmission, gear changes adapt to the specifics of the job at hand. For the driver, this is a completely new perception, as he only feels a slight hesitation when shifting to the next gear. In addition, the new Sense Clutch function is added, which enables the driver to smooth the power flow.

To ensure stable operation of the tractor during plowing or transport work, the transmission control has been optimized: electronics control the connection of the four-wheel drive and the differential lock depending on the travel speed and wheel angle.

The P-version tractors are equipped with an automatic transmission, where the electronic control system selects the appropriate gears in each range, optimizing engine performance and reducing fuel consumption.

The Lamborghini tractors of the R8, R7, R6 and R5 series are equipped with the "PowerShift" automatic transmission with automatic shifting. The automatic transmission is controlled by an electronic unit that selects the optimum gear according to the current load and crankshaft speed at a given time. The R8 series automatically shifts under load without interrupting the power flow, allowing the operator to focus on the job at hand.

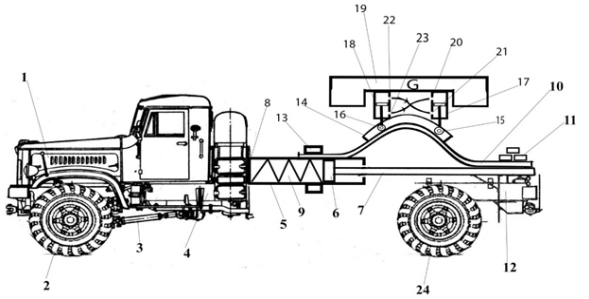
Formulation of the research objective

To improve the technology of transmitting torque from the engine to the wheeled propulsion by creating a new transmission design for a mobile energy vehicle.

To develop a design and technological design of a traction vehicle with all-terrain wheeled propulsion.

Presentation of the main research material

Fig. 2 shows the Schemes of mobile energy vehicles with energy resonator interbridge nozzle: a. – general view of the vehicle with energy resonator interbridge nozzle; b. – mobile energy vehicle with energy resonator interbridge nozzle in the absence of movement (discomfort of the bearing surface); c. – mobile energy vehicle with energy resonator interbridge nozzle in dynamics (beginning of movement).



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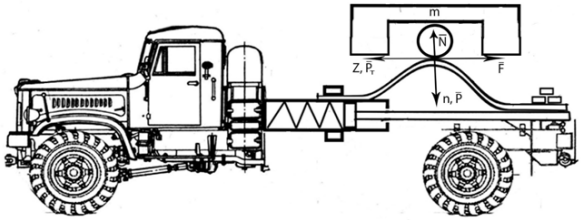

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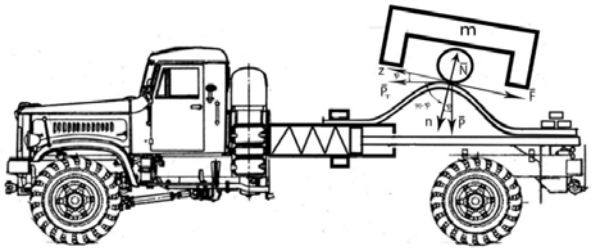

c

Fig. 2. schemes of mobile energy vehicles with energy resonant inter-bridge attachment: a. – general view of a vehicle with energy resonant inter-bridge attachment; b. – mobile energy vehicle with energy resonant inter-bridge attachment in the absence of movement (discomfort of the bearing surface); c. – mobile energy vehicle with energy resonant inter-bridge attachment in dynamics (beginning of movement)

Description of the design of force loading by the torque of a car wheel with a reactive impulse in the area of its contact with the bearing surface.

In order to increase the efficiency of the vehicle transmission and reduce fuel consumption for moving a loaded vehicle, a method of moving the "Camel" car by L.M. Petrov, which was performed on a modernized transmission, produced by the Ukrainian automobile plant, KrAZ-5233, is proposed.

Fig. 2 shows a drawing of a car with a modernized transmission in a stationary state. The method of moving the vehicle "Camel" includes: engine 1, wheeled propulsion 2, drive 3 to the wheeled propulsion 2. A cylinder 5 is attached to the half-frame 4, in which a piston 6 with a rod 7 is located with the possibility of movement. A compression spring 9 is located in the cylinder 5 between the end wall 8 and the piston 6. The elastic element 10 is fixed to the rod 7 and the subframe 12 at one end with the help of the connecting element 11, and the other end is connected to the cylinder 5 with a clamp 13. A flexible guide 14 is fixed on the elastic element 10. In the guide 14, with the possibility of movement on rollers 15 and 16, there are cylinders 17 and 18, which are fixed on a gravity weight 19. In the cylinder 17 there are holes 20 and 21, and in the cylinder 18 there are holes 22 and 23, wherein hole 20 is connected to hole 23, and hole 21 is connected to hole 22.A wheel 24 is rotatably connected to the subframe 12.

The method of moving the car *Camel* by L. M. Petrov is performed as follows. When the car is moved from the engine 1, the drive 3 supplies torque to the wheel motors 2. The car starts to move. The following operations are performed. The semi-frame 4 together with the cylinder 5 is moved in the direction of movement of the car, and the rod 7 together with the subframe 12 and the wheel 24 with the compression spring 9 slows down the movement of the wheel 24 together with the connecting element 11 fixed on the rod 7 and the subframe 12. The compression spring 9 is stretched, the elastic element 10 is deformed in the opposite direction under the action of the gravitational weight 19. The gravitational weight 19 under the action of the inertial component moves on rollers 15 and 16 along the guide 14 and tracks the movement of the bulge of the elastic element 10 in the opposite direction to the direction of movement of the car. Such a combination of interrelated operations between the wheel movers 2 and the supporting wheels 24 accumulates potential energy [3; 4].

Theoretical studies of the design of force loading by the torque of a car wheel with a jet impulse in the area of its contact with the bearing surface

In order to describe the motion of a vehicle with an energy resonator bridge nozzle, we draw up its equation of motion, Fig. 2. To draw up this equation for a vehicle with an energy resonator bridge head, we replace rollers 15 and 16 with one and assume that the technological weight m will move along the flexible guide 14 [2; 3; 4; 5].

Let us represent the active forces:

P is the weight of the technological platform

Pt is the traction force acting from the rod 7. Let's release the point M from the ties by replacing the action of the ties with a reaction. The link is the roughness of the flexible guide 14. The reaction of the flexible guide is decomposed into two components:

$\overline{X}$ is the normal component and F is the tangential component (friction, sliding force).

Let's connect the coordinate axes to the technological platform. Then the differential equation of motion of the technological platform in the usual form will be as follows:

$$m = \frac{d\theta}{dt} = R_\tau, \; m\frac{\theta^{c}}{r} = R_n \tag{1}$$

In vector form, the equation of motion will look like this:

$$R_\tau = P_\tau + F_\tau + N_\tau + P_{T\tau} \tag{2}$$

$$R_n = P_n + F_n + N_n + P_{Tn} \tag{3}$$

After mathematical transformations, the general solution to the differentiated equation of motion of the technological platform and the car will be as follows:

$$V^2 = e^{-2\cdot\varphi+c} + A\cos\varphi + B\sin\varphi \tag{4}$$

To determine the free constant c, we write the initial conditions:

Under the assumed initial conditions: $t = 0; \varphi(0) = 0; V(0) = 0$

After substituting the initial conditions of the car's movement into Equation (4), we obtain:

$$-A = e^{c}$$

Then the final equation of motion of the car takes the form:

$$V^2 = -A_e^{-2\cdot\varphi} + 2fg\cos\varphi + 2g\sin\varphi$$

$$V^2 = -2gfe^{-2\cdot\varphi} + 2fg\cos\varphi + 2g\sin\varphi$$

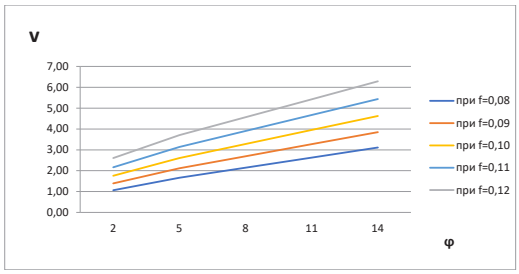

Fig. 3. Graphical display of vehicle movement by the "Camel" method

Conclusions

As a result of the research, a car with modernized wheel propulsion systems was tested:

1. The conducted patent search for directions of improvement of wheel propulsion of the car allowed to identify possible directions of modernization of the wheel propulsion.
2. To modernize the wheeled propulsion system, it is proposed to include a moving weight in the contact and exit zone that acts on the flexible element within its deflection (150–250 mm).
3. For the modernization of the wheeled propulsion system, it is proposed to include a movable weight within the vehicle lifting capacity (10000N–20000N) in the contact patch and exit zone, which acts on the flexible element included in the truck transmission.
4. The experiments carried out at the OF NATI test site revealed the advantage of modernized wheel thrusters in comparison with the existing ones in the force of traction by 15%.
5. According to the results of the experiments, graphical dependencies were built.
6. A model of a car with modernized wheel propulsion systems was developed.

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