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Concept of Drive of Sport Techniques in 21 Century

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Abstract

The modern sports techniques (cars, motorcycles, bicycles) is drove in motion with use of transmissions with the controlled variable transfer ratio. The transmission provides variable speed of movement depending on external loading. The modern transmission has the step transfer ratio (4 - 5 steps). At each step the transfer ratio constant, and speed of movement is regulated by change of engine power. Achievement of the maximum speed of movement demands optimum control of switching of steps and the engine power.

Control of steps switching (both manual, and automatic) almost always is not the best. The moment of switching either lags, or advances optimum time of switching which depends on controlled power of the engine. Therefore achievement of the maximum speed of movement substantially depends on individual abilities of the driver. But even the big practical experience of the driver does not allow receiving the greatest possible result.

The ideal variant for a drive of sports techniques is not switched stepless transmission which provides the maximum possible speed of movement at any resistance to movement. The driver is controlling only by power of the engine choosing an optimum mode of movement.

V-belt self-regulated drive is capable to provide stepless regulation of speed of movement but it is insufficiently reliable and durable.

The tooth gearing is reliable and durable but it is not stepless transfer. The automatic gear box provides only automatic switching of steps which is not optimum. Besides, the automatic gear box is heavy and bulky. Such transmission cannot be established on a motorcycle or a bicycle.

The modern science about mechanisms and machines has opened essentially new phenomenon - effect of mechanical force adaptation [1, 2 and 3]. According to this discovery the gear closed differential mechanism with two degrees of

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freedom provides movement of a output shaft with a speed inverse to the resistance moment.

Attempts of patenting of the closed differential mechanism with two degrees of freedom as self-regulated mechanism were undertaken earlier [4, 5] but they did not contain a scientific substantiation of adaptation effect. These patents could not be used for creation of concrete designs with the set parameters of movement.

The patents developed on the basis of the discovery [6, 7] allow creating self-regulated gear stepless transfer with the set range of the transfer ratio. Such transfer is named by adaptive transfer.

The gear adaptive transfer developed on the basis of the discovery has the elementary design and does not require any control. This transfer independently and continuously adapts to variable loading. Absence of management excludes subjective factors and provides ideal conformity to a variable mode of movement. Simplicity of a design allows establishing transfer on any sports vehicle (car, motorcycle, bicycle etc).

The concept of a drive of sports technique in 21 century consists in use of an adaptive gear transmission for sports vehicles.

In the present report the description of an adaptive tooth gearing, the basic laws of interconnection of parameters, animation model and pre-production model tests is presented

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Keywords: adaptive mechanism; continuously variable transmission; closed contour;

1. Introduction

Here introduce the paper, and put a nomenclature if necessary, in a box with the same font size as the rest of the paper. The paragraphs continue from here and are only separated by headings, subheadings, images and formulae. The section headings are arranged by numbers, bold and 10 pt. Here follows further instructions for authors.

Recently there were patents on not switched gear continuously variable transmission (CVT) without hydro transformer [6, 7]. In transmission wheelwork with two degrees of freedom and one entrance is used. Adaptive mechanism of CVT provides possibility of output link movement with a speed inversely to resistance moment at constant input power. Researches of wheelworks with two degrees of freedom executed before define possibility of their self-regulation or adaptation to variable technological loading. However the theoretical description of such transmissions is not convincing enough. This transfer has one entrance and does not satisfy the requirements of mechanism theory about the equality of degrees of freedom number to input links number [8]. The inventors of the patented projects [4, 5] used the intuitive assumptions based on the existing ideas of the theory of mechanisms. The essentially new regularity of mechanics takes place at the basis of mechanical adaptive transmission acting [1, 2 and 3]. Purpose of present work is to formulate regularities of the mechanics allowing creating the adaptive-mechanical continuously variable transmission for the sport techniques.

2.Description of the gear adaptive drive

The gear adaptive drive implementing the force adaptation effect represents the closed differential mechanism (Fig. 1). It contains the frame 0, one input carrier H_1, a closed four-link contour with toothed wheels 1-2-3-6-5-4 and the output carrier H_2. Solar wheels 1, 4 are united in the block of wheels 1-4. Ring wheels 3, 6 are united in the block of wheels 3-6.

The input motive force F_1 is transferred from input link H_1 to a point B. Output force of resistance R_6 is transferred from output link H_2 to a point K. Application points B and K of a contour have external

displacements s_B, s_K. Application points C, E, D, G of the of internal forces of a contour (reactions) R_{32}, R_{65}, R_{12}, R_{45} have internal displacements s_C, s_E, s_D, s_G.

If external displacements of points B and K are known then a contour internal displacements of points s_C, s_E, s_D, s_G are is univocal determined.

Theorem. Closed contour moving under the acting of any superposed forces is in balance.

For the theorem demonstration we will consider balance of all links of contour.

For links 2 and 5 conditions of balance look like reactions in the kinematic pairs expressed through superposed forces

$$R_{12} = R_{32} = 0.5F_{H1}. \quad (1)$$

$$R_{45} = R_{65} = 0.5R_{H2}. \quad (2)$$

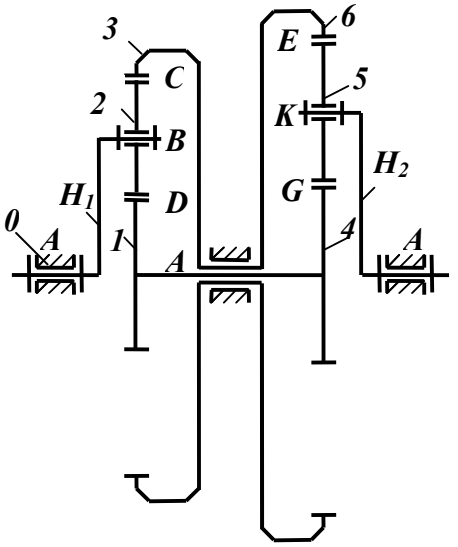

Fig.1. Mechanical stepless adjustable drive

Here $F_{H1} = M_{H1} / r_{H1}$, $R_{12} = M_{12} / r_1$, $R_{32} = M_{32} / r_3$,

$R_{H2} = M_{H2} / r_{H2}$, $R_{45} = M_{45} / r_4$, $R_{65} = M_{65} / r_6$, r_{H1}, r_{H2} - radiuses of the entrance and target carriers, M_{12}, M_{32} - moments created on the satellite 2 by reactions from toothed wheels 1 and 3, M_{45}, M_{65} - moments created on the satellite 5 by reactions from toothed wheels 4 and 6, r_i $(i = 1, 2...6)$ - radiuses of wheels.

Opposite directed moments are transferred to intermediate links 1-4 and 3-6 from satellites 2 and 5

$$M_{21} = 0.5M_{H1}r_1 / r_{H1}, M_{23} = 0.5M_{H1}r_3 / r_{H1},$$

$$M_{54} = 0.5M_{H2}r_4 / r_{H2}, M_{56} = 0.5M_{H2}r_6 / r_{H2}. \quad (3)$$

At any external moments the moments on blocks of wheels 1-4 and 3-6 will appear unbalanced ($M_{21} \neq M_{54}, M_{23} \neq M_{56}$). However these moments are gained on the basis of use of balance conditions of satellites 2 and 5 interacting with links 1-4 and 3-6. Absence of balance on links 1-4 and 3-6 contradicts balance observance on satellites 2 and 5.

Let's muster presence of contour links balance by principle of virtual works.

Let's make for each satellite an equilibrium Eq. by principle of virtual works. We will gain for satellites 2 and 5: $R_{12}s_D + R_{32}s_C = F_{H1}s_B, R_{45}s_G + R_{65}s_E = F_{H2}s_K$

Let's express here displacements s of points through instant angles of turn of links and radiuses: $s_D = \varphi_1 r_1, s_C = \varphi_3 r_3, s_B = \varphi_{H1} r_{H1}, s_G = \varphi_4 r_4, s_E = \varphi_6 r_6, s_K = \varphi_{H2} r_{H2}$,

- $\varphi_1, \varphi_3, \varphi_{H2}, \varphi_4, \varphi_6, \varphi_{H2}$ - instant angles of turn of toothed wheels and carriers.

With the account $\varphi_1 = \varphi_4, \varphi_3 = \varphi_6$ and a time we will gain

$$M_{12}\omega_1 + M_{32}\omega_3 = M_{H1}\omega_{H1} \quad (4)$$

$$M_{45}\omega_1 + M_{65}\omega_3 = M_{H2}\omega_{H2}. \quad (5)$$

As satellites 2 and 5 are a part of the mechanism as a whole we will combine the made expressions for satellites. We will gain a condition of parameters interacting for mechanism as a whole

$$M_{12}\omega_1 + M_{32}\omega_3 + M_{45}\omega_1 + M_{65}\omega_3 = M_{H1}\omega_{H1} + M_{H2}\omega_{H2}. \quad (6)$$

In the right side of an Eq. the sum of powers of contour superposed forces takes place.

Let's assume that the necessary condition of balance of the kinematic chain is carried out also and the right side of an Eq. (6) is equal to null

$$M_{H1}\omega_{H1} + M_{H2}\omega_{H2} = 0. \quad (7)$$

Then also the left side of an Eq. (6) will appear equal to null. With the account $M_{12} = -M_{21}, M_{32} = -M_{23}, M_{45} = -M_{54}, M_{65} = -M_{56}$ we will gain

$$(M_{21} + M_{54})\omega_1 + (M_{23} + M_{56})\omega_3 = 0. \quad (8)$$

The Eq. (8) represents the equation of works (powers) on intermediate links 1-4 and 3-6. The Eq. (8) means balance presence on intermediate links 1-4 and 3-6 simultaneously. In the mobile closed contour basic new situation occurs: balance in statics separately on each intermediate link is absent but balance of intermediate links simultaneously on the movement all contour takes place. Hence if the condition of balance for external links of a moving kinematic chain is fulfillment then for all links of a contour simultaneously

balance conditions are carried out.

Thus, it is proved, that the closed contour, moving under the influence of any superposed forces, is in balance.

Consequence 1 . The kinematic chain with the closed contour provides stepless transfer regulating that is possesses effect of power adaptation.

From the formula (7) it is possible to define target angular speed

$$\omega_{H2} = M_{H1}\omega_{H1} / M_{H2}. \tag{9}$$

According to Eq. (9) at a constant input power the target angular speed is inverse to variable target moment of resistance M_{H2}.

Consequence 2. In the closed contour energy circulation occurs.

The Eq. (8) contains positive and negative members and characterizes balance of powers on intermediate links of a contour.

As $M_{54} > M_{21}$, $M_{23} > M_{56}$ then from the Eq. (8) we will gain

$$-(M_{54} - M_{21})\omega_1 + (M_{23} - M_{56})\omega_3 = 0. \tag{10}$$

From here

$$(M_{54} - M_{21})\omega_1 = (M_{23} - M_{56})\omega_3. \tag{11}$$

The Eq. (11) reflects the phenomenon of circulation of energy unknown earlier.

Creation of gear stepless adjustable transfer in the form of the gear closed differential mechanism with two degrees of freedom is theoretically proved. The found regularity allows to synthesis gear stepless adjustable transfer on the set operational parameters of motion, to execute the kinematic and dynamic analysis of transfer and to define transmission design data.

Computer animation model of toothed continuously variable transmission (Fig. 2) presented on a site: http://www.madbass.narod.ru/. The animation model allows seeing a change of motion of links at change of external loading.

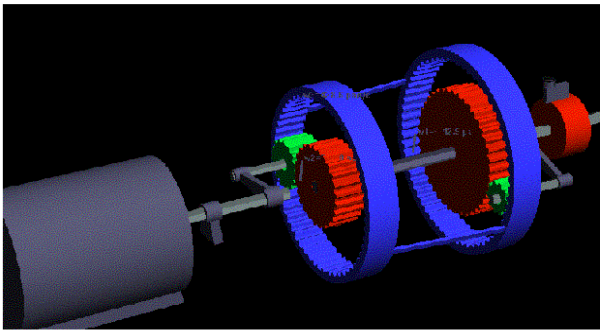

Fig.2. Computer animation model

This icon allows activating the animation model (gear variator with constant engagement of wheels).

Adaptive Gear Variator.EXE

To activate animation model of toothed adaptive stepless transfer (CVT):

1. To bring the cursor to a badge. 2. To press the right button. 3. To choose « Object the Package ».

4. To make «Active contents». 5. Buttons of an arrow are turning the model. 6. Button " W " increases target loading. 7. Button " Q " reduces target loading

Action of the animation model: Press key W - you will see motion of cogwheels if external loading is increasing. Press key Q - you will see motion of cogwheels if external loading is decreasing. Speed of rotation of the engine shaft is constant. Speed of rotation of the output shaft depends on loading.

Keys with arrows change position of gear variator in space.

3.Experimental check of motion definability and force adaptation effect in the adaptive mechanism

Check of effect of force adaptation in the mechanism made under the chart design presented on fig. 1 has been executed on the test-bed (fig. 3). At the stand the electric motor is placed at the left, the electric oscillator simulating useful output loading is placed on the right, adaptive-mechanical transmission is placed in the centre between the electric motor and the electric oscillator. Theoretical results are coinciding with results of check at the stand.

4.Conclusion

Adaptive gear transmission in the form of gear differential mechanism with closed contour provides the best variant of control with the transfer ratio of sports transport. The adaptive tooth gearing independently and continuously brings vehicle speed into accord to movement resistance without any control system. It leads automatically to achievement of the maximum speed of movement. Absence of control excludes subjective factors and provides ideal conformity to a variable mode of movement.

The gear adaptive transfer developed on the basis of science discovery has the simplest design, sizes and weight. Simplicity of a design allows to establish transfer on any sports vehicle (car, motorcycle, bicycle).

Concept of drive of sports techniques in 21 century consists in use of adaptive gear transmissions.

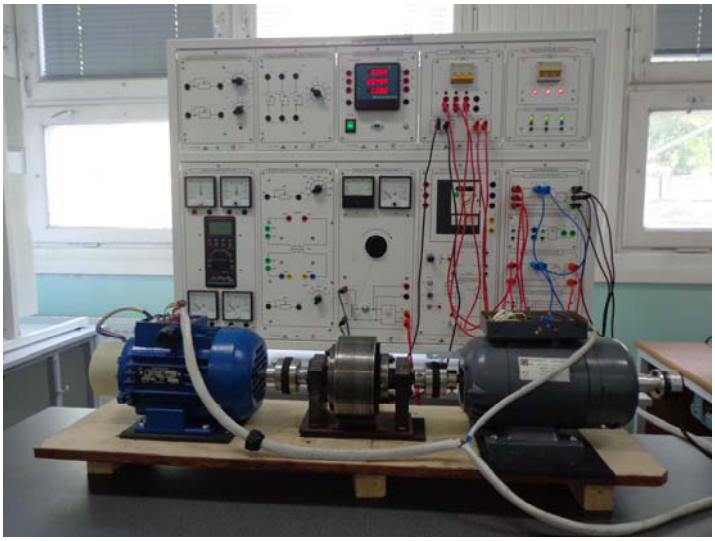

Fig.3. Stand for check of adaptive-mechanical stepless transmission

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