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New Design of the Automobile Automatic Gearbox Providing Driving Simplification and Driver Fatigue Decrease

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Abstract

The article examines the possibility of decreasing driver fatigue and work intensity influencing the traffic safety and road accident prevention, with the focus on route vehicles operating in the urban cycle. As a tool to solve the task, designs of gearboxes used in vehicles are studied. A new design for a four stage automatic gearbox, shifting gears automatically without use of external energy and providing for continuous transmission, is suggested. It allows for decrease of driver fatigue and work intensity, significant decrease of gearbox cost, multiple enhancement of reliability, reduction of clutch operation costs, enhancement of driver's attention concentration on road conditions and improvement of the traffic safety.

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1. Main text

One of the main reserves for road accident prevention lies in decreasing driver fatigue and work intensity, particularly on route vehicles in the urban cycle. This decrease is achieved due to vehicle driving simplification and reduction of driver's physical load, allowing concentrating on road conditions. It results in the enhancement of the traffic safety and decrease of the degree of influence of driver's qualification and personal characteristics on the operational indices of a vehicle [Kurochkin (2008)].

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In turn, driver fatigue and work intensity depend largely on transmission unit design and, first of all, on gearboxes used in vehicles. Thus, a driver of a bus equipped with the mechanical gear with manual shifting needs to shift a gearbox lever about 1500–2000 per a shift, releasing clutch at each shifting which cannot but negatively influence the traffic safety.

There are five main types of modern gearbox designs, advantages and disadvantages of which are given in Table 1.

Table 1. Advantages and disadvantages of vehicle gearboxes.

Gearbox type	Advantages	Disadvantages
Mechanical gearbox with manual shifting	<ul style="list-style-type: none"> • simple design; • low price; • efficiency 	<ul style="list-style-type: none"> • increases driver fatigue and work intensity due to gear shifting and clutch release, particularly in the urban cycle; • no continuous transmission when shifting.
Mechanical gearbox with automatic clutch	decreases driver fatigue only partially due to the elimination of the necessity for clutch release	<ul style="list-style-type: none"> • the price is twice as high if compared to the first type; • no continuous transmission when shifting.
Automated mechanical gearbox	decreases driver fatigue	<ul style="list-style-type: none"> • the price is high enough; • requires the high pressure of the power liquid and, consequently, a high-duty pump driven by the vehicle engine; it results in engine net power decrease and fuel consumption increase, particularly, in the urban cycle, which is explained by the fact that, for operation of a pump with an idle engine, overspeed of the cranked shaft is required; • no continuous transmission when shifting
Hydromechanical transmission with electronic control	<ul style="list-style-type: none"> • decreases driver fatigue; • upon blocking a torque converter on high gears in suburban traffic, it is compared to mechanical gearboxes in efficiency 	<ul style="list-style-type: none"> • the price is about thrice as high if compared to mechanical gearboxes; • significant power input to torque converter stall and a hydraulic pump drive for compression of clutch friction disks; • in the urban cycle, the result is lower than the one mechanical gearboxes show; • notable loss of vehicle dynamic qualities, about 5%.
Variator (continuously variable transmission)	decreases driver fatigue due to continuously variable transmission	<ul style="list-style-type: none"> • their mass is bigger and efficiency coefficient is smaller, they are much more expensive than mechanical gearboxes; • increased power input to the control system operation; • the transformation coefficient is smaller than required for speed cars with high-speed engines; • maximum transmitted power is technologically limited to 100 kWt [Dolgikh (2014)].

The analysis of gearbox advantages and disadvantages explains the interest of specialists in the automatic two-speed gearbox suggested by Antonov [Gladkov and Petrenko (2002)]. It does not require external energy for shifting gears, contains an epicyclic cylindrical helical gearbox with a blocked sun gear rigidly connected with a gearbox

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