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THE EMERGENCE AND EVOLUTION OF AUTOMATIC TRANSMISSION TECHNOLOGY

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Annotation. This article analyzes the emergence and development stages of the automatic transmission, the operational characteristics of mechanical transmission synchronizers, and their impact on driver performance. The first automatic transmission developed by General Motors and its evolution from a hydraulic clutch to a hydraulic transformer are highlighted. Additionally, the structural design of the hydraulic transformer, the principle of torque transmission, and the advantages of automatic torque control in accordance with the vehicle's driving conditions have been scientifically substantiated.

Keywords: Automatic gearbox, mechanical gearbox, synchronizer, hydrotransformer, hydraulic coupling, torque, transmission.

Mechanical transmission (MDC) synchronizers ensure the convenience of gear shifting in various vehicle speed modes, but in this situation, they require a high level of driver attention. The capabilities of the automatic transmission are extensive to relieve drivers of such inconveniences and moral burdens, as well as to increase the convenience of driving the vehicle [1].

In this regard, General Motors' first automatic transmission was a 4-speed automatically controlled transmission equipped with a hydraulic coupling.

It evolved into a hydraulic transformer over time, making the connection more smooth and efficient.[2]

The hydrotransformer, along with the turbine and pump wheels, also has a reactor, which transmits the torque from the engine very smoothly through the working fluid - oil. In this case, the magnitude of the torque changes automatically (depending on the vehicle's speed and road conditions). The pump wheel of the AUQ is connected to the engine crankshaft, while the turbine wheel is connected to the drive shaft of the UQ (Fig. 1) [3].



Figure 1. Automatic gearbox

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At the same time, AUQs have the following disadvantages:

A car equipped with a gearbox has higher fuel consumption than a car equipped with a MUQ;

A vehicle equipped with a gearbox may be towed only in exceptional cases, provided that all safety measures are strictly observed. In such situations, it is advisable to use the services of an evacuator [4].

AUQ of sequential type

The sequential-type car gearbox does not differ significantly from the mechanical UQ. In it, the transmissions are automatically controlled by a special hydromechanical system. The steering is controlled by the machine's electronic system, and there is no need for the clutch pedal. In this transmission, sequentiality (sequential, English: sequence) refers to a strict sequence of gear changes; that is, the gears are required to pass each stage in a strict sequence from bottom to top and vice versa [5].

This type of automatic transmission is also widely used in tractors, as it uses multiple gears with a wide range of torque changes [6].

Robotic (Automatically Controlled Mechanical Gearbox) UQ

In terms of design and operating principle, the robotic transmission is largely compatible with the technical characteristics of a standard manual transmission. It also has three main shafts (driven, leading, and intermediate), with identical gears and gear ratios. The term "robot" means that all processes are controlled by special devices—"servo drives" and "actuators"—which perform the functions of connecting and disconnecting the drive when necessary. Control of these processes is carried out using a special electronic unit, which transmits the control command to an electric motor with a gearbox or hydraulic drive (Fig. 2) [7].



Figure 2. Automatically controlled manual transmission

A driver of a vehicle equipped with a robotic UQ can entrust the vehicle to automatic control by relying on a computer, or manually control the vehicle using a lever or leaflet selector placed under the steering wheel to switch gears [8].

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Disadvantages of robotic UQ:

<e0> when moving in difficult conditions, the clutch cannot be controlled smoothly, as frequent gear changes cause inconvenience;

<e0> When switching from one gear to another, the long-term separation of the drive and driven discs reduces engine flexibility and leads to a slight decrease in machine speed [9].

A robotic UQ equipped with two clutches

To eliminate the aforementioned shortcomings, the robotic UQ was equipped with two clutches. The use of such a design significantly increases the capabilities of the unit; that is, alongside the currently operating drive, it is possible to pre-connect it by selecting the next drive to be connected (Fig. 3).



Figure 3. Robotic gearbox equipped with two clutches

As a result, the transition time from one transmission to another is significantly reduced, the vehicle's maneuverability increases, and its handling becomes more convenient.

The variator type of transmission is considered stepless. The worm of such transmissions is capable of smoothly transmitting torque (Fig. 4).

In essence, a variator is a stepless "automatic machine" that does not have a constant gear ratio.



Figure 4. AUQ with variator

As an automatic transmission unit, the variator has the following advantages:

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its design does not contain gears or shafts, as it is not required to systematically change a specific torque value without disconnecting the engine from the transmission;

it does not have gear stages with a specific number of gears;

the torque transmitted by the variator to the drive shaft constantly changes depending on the position of the wedge belt relative to the conical pulleys;

the smoothness and softness of the transmission equipped with a variator are almost ideal.

Despite the fact that these variator achievements are revolutionary designs in the automotive industry, they are currently used in low-power vehicles. Their main disadvantages are low resource (up to approximately 200,000 *km*) and high service costs.

Tiptronic

The term "Tiptronic" should be used in relation to the emergence of the functional capability of the UX by installing an additional device into its design, rather than a specific type of UX (Fig. 5) [10].



Figure 5. AUQ control lever with typtronic function

The standard form of the AUQ used in vehicles does not allow for the control of certain dynamic parameters, such as high (speed) acceleration, engine braking, or forced transition to low gear, etc. In these cases, the "tiptronic" function solves these problems through an auxiliary speed control system linked to electronic control using a lever selector (Fig. 6).

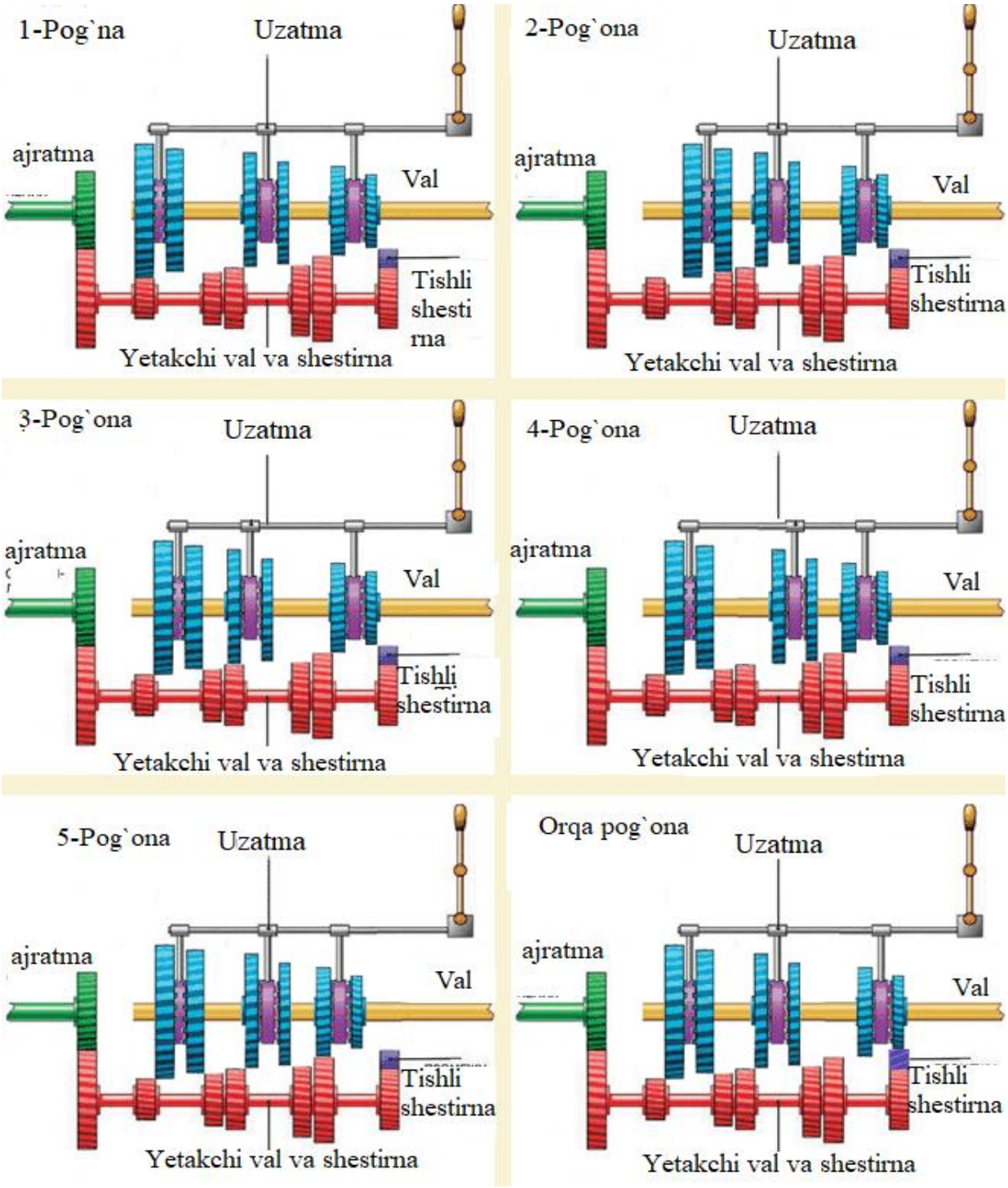


Figure 6. Gearbox

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Current state, challenges, and development prospects of engines and powertrains for land transport systems

Structure and operating principle of a car gearbox



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