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Development of a multistage gearbox for a new generation of heavy-duty trucks

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Abstract. The design of a multistage transmission for heavy trucks (patent No. 2508486) designed to implement the national program of import substitution in transport engineering in Russia. The main technical results implemented in the design of multi-stage gearbox.

1. Introduction

The national policy of import substitution in transport engineering in Russia began to be implemented at the very beginning of the XXI century. And in 2014, when economic sanctions were imposed, the policy of import substitution accelerated markedly and acquired the status of state importance. Large automakers develop their development programs, focusing on the import substitution program. Thus, the program of strategic development of PJSC "KAMAZ" has defined the main task of bringing to the market KAMAZ trucks of a new generation with fundamentally different technical characteristics and consumer properties. Multistage gearboxes will be used in the transmission of this generation of trucks.

Obviously, the designers of multi-stage gearboxes face the following tasks:

- creation of a reliable and rigid gearbox design with smaller dimensions and weight;
- increase the speed and smoothness of the transmission range of the divider without breaking the power flow and without turning off the clutch;
- providing the ability to test separate nodes transmission (differential divider, a main reducer and differential dual), which increases the quality of the overall assembly of the transmission conditions of mass production.

2. Development of a multistage gearbox

Now at Kazan Federal University the design of a multistage transmission with a differential divider and a demultiplikator in which the following technical results are realized is developed and patented:

The old sample divider, formed by a gear drive with a synchronizer, is replaced by a differential divider. Differential divider provides a significant reduction in the axial dimensions of the gearbox, the weight of the secondary and intermediate shafts. Also, the differential divider provides smooth control of the transmission ratio, which follows the design, which causes a reduction in the weight of the gearbox.

The use of a differential divider in the design of the gearbox allows you to switch the range of the divider without switching off the clutch smoothly and without breaking the power flow, which reduces wear and tear of friction clutch parts, increasing the power factor and increasing the fuel efficiency of

the engine. At the moment of switching the divider range, which occur four times more often than the gear shift of the main gearbox, the engine does not go into partial load modes.

2. An additional series of toothed gears reverse eliminated by the application of a differential auxiliary gearbox with an integrated reverse gear. The differential demultiplikator with integrated rear transmission additionally reduces the axial dimensions and weight of the secondary and intermediate shafts. The use of an integrated rear-end differential demultiplikator allows the full power of the engine to be transmitted when the vehicle is in operation at different reversing speeds, which is particularly important for special-purpose vehicles.

3. The rigidity of the shafts of the main gear is increased by reducing their axial dimensions, therefore, their moments of inertia are reduced. This contributes to a faster alignment of the angular velocities of the rotating masses, reducing the load on the synchronizers, therefore, less wear blocking rings synchronizers when switching gears and faster gear shifting.

4. Increasing the reliability of the gearbox, since the technological process of its assembly can be carried out after preliminary bench tests of its individual components, namely, the differential divider, the main reducer and the differential demultiplikator, which in turn creates the prerequisites for automating the process of the general assembly of the gearbox.

The design of the multistage gearbox is presented in fig.1.

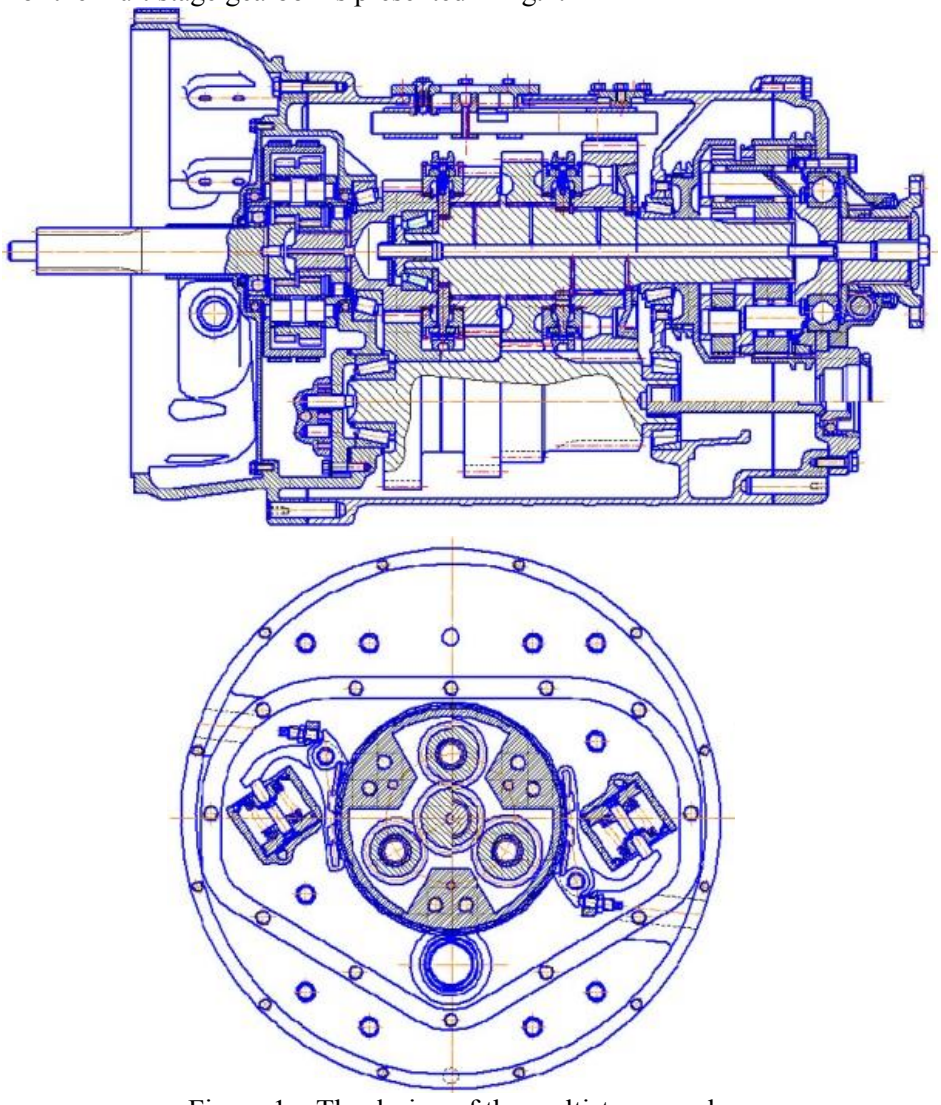

Figure 1 – The design of the multistage gearbox

2.1. The design of the gearbox.

For fig.2 shows the kinematic scheme of the proposed transmission. The gearbox consists of a differential divider, a main four-speed gearbox and a differential demultiplikator with integrated rear transmission.

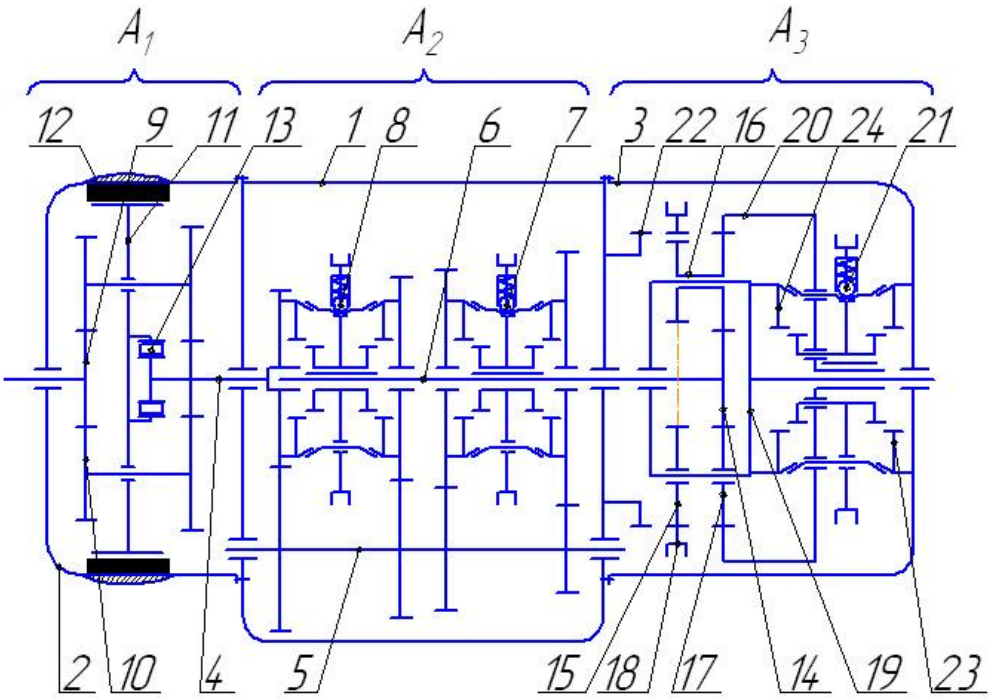

Figure 2 – The kinematic scheme of the multistage transmission: A_1 – differential divider; A_2 – main gearbox; A_3 – differential demultiplikator; 1 – the body of the main gearbox; 2 – clutch housing (crankcase differential divider); 3 – crankcase differential demultiplikator; 4 – the main shaft of the main gearbox; 5 – intermediate shaft of the main gearbox; 6 – the secondary shaft of the main gearbox; 7 and 8 – synchronizers, respectively, the first-second and third-fourth gear of the main gearbox; 9 – input shaft-gear differential divider; 10 – two-crown satellites of the differential divider; 11 – carrier of the differential divider; 12 – band brake; 13 – free-wheeling clutch; 14 – a leading gear ring of the differential demultiplikator; 15 – satellites of the differential demultiplikator; 16 – two-crown satellites of the differential demultiplikator; 17 – revers idler satellites of the differential demultiplikator; 18 – crown wheel (reverse clutch) of the differential demultiplikator; 19 – carrier of the differential demultiplikator (the output shaft of the gearbox); 20 – crown wheel of the differential demultiplikator; 21 – synchronizer of the differential demultiplikator; 22 – ring gear lock the reverse clutch; 23 – toothed crown locking the crown wheel of the differential demultiplikator; 24 – ring gear locking differential demultiplikator

The gearbox contains the body of the main gearbox 1 with holes for fastening the clutch housing 2, which is simultaneously the crankcase of the differential divider, and the crankcase of the differential demultiplikator 3. The body of the main gearbox with clutch housing forms a closed cavity, which contains the main shaft 4, the intermediate shaft 5 and the secondary shaft 6 of the main gearbox. The input shaft is the shaft-gear resting on the roller bearing, installed in the hole of the clutch housing. The intermediate shaft is supported by two roller bearings mounted in the holes of the housing and the clutch housing. The secondary shaft is supported at one end by a roller bearing mounted in the main shaft and at the other end by a roller bearing mounted in the body of the main gearbox.

The differential divider contains the input shaft-gear 9, which is in engagement with the two-crown satellites 10, mounted on the axes pressed into the carrier of the differential divider 11. The carrier of the differential divider rests on the ball bearings installed in the clutch housing and in the cover of the

differential divider, and is blocked by the band brake 12. Between the carrier 11 and the main shaft of the main gearbox 4 installed free-wheeling clutch 13.

Differential demultiplikator contains a leading gear ring 14, cut on the secondary shaft of the main gearbox, satellites 15 and two-crown satellites 16, revers idler satellites 17, crown wheel 18, which is simultaneously the reverse clutch, the carrier of the demultiplikator 19, which is simultaneously the output shaft of the gearbox, and the crown wheel 20. On the splines of the hub of the crown wheel mounted synchronizer of the differential demultiplikator 21. The carrier of the demultiplikator rests on a ball bearing mounted in the crankcase of the differential demultiplikator 3. The body of the main gear fixed gear ring 22, designed to lock the crown wheel 18, in the crankcase of the differential demultiplikator fixed toothed crown 23, designed for the locking crown wheel 20, and the carrier fixed ring gear 24 designed to lock the differential demultiplikator.

The 3-D model of the transmission was also developed using the application software of the computer-aided design system. 3-D model of the gearbox is shown in Fig.3.

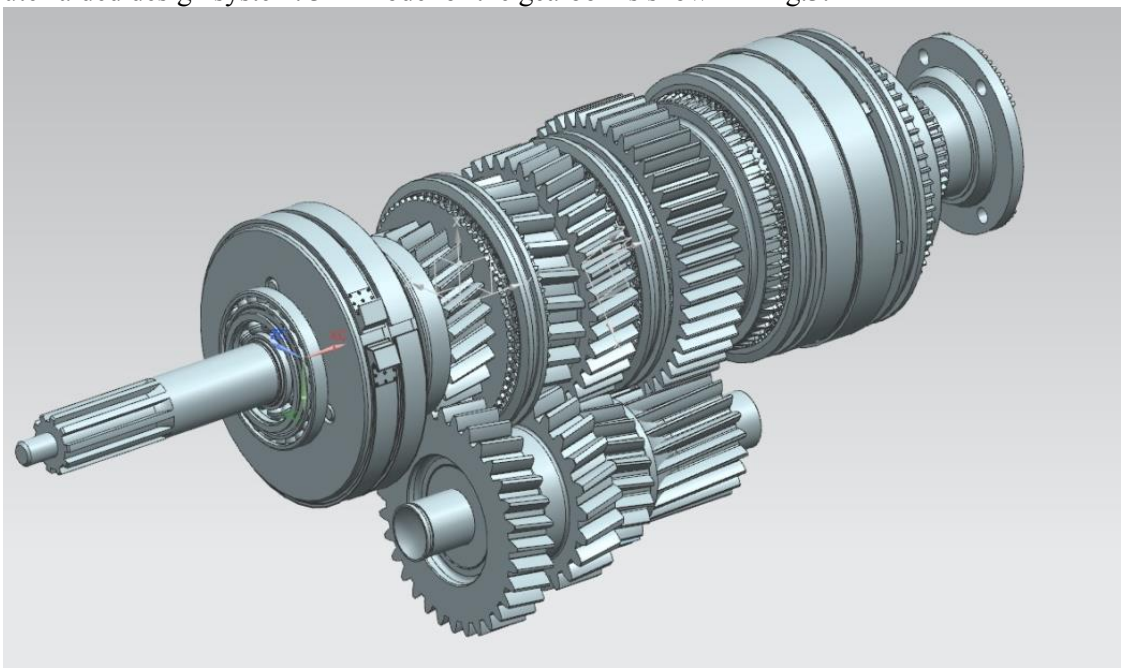

Figure 3 – 3-D model of the gearbox

The offered automobile multistage transmission is competitive, possesses technical characteristics corresponding to requirements of modern automotive industry and completely meets requirements of the state Program of the Russian Federation "Development of the industry and increase of its competitiveness" (the order of the government No. 328 of 15.04.14).

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