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Types of Steering and Their Design Aspects

Jenis Kemudi dan Aspek Desainnya

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Abstract

This article provides information about steering mechanisms, their types and designs. It was also discussed in which vehicles these steering gear designs could be used.

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Introduction

Steering mechanisms. The more gears, the easier the drive wheels turn. However, with an increase in the number of gears, the turn time of the drive wheels also increases. But the size of the number of gears, in turn, increases the time spent turning the driven wheels. For example, if the steering gear ratio is 50, the time required to turn the drive wheels 30 degrees is relatively long, and the steering wheel needs to be turned more than four times. This situation makes it difficult for modern high-speed cars to turn around in a short time. Accordingly, the number of steering gears is limited to a predetermined value.

To reduce ground impacts on the steering wheel, steering gears with a variable number of gears are used. One means of reducing the effect on the ground rudder is to reduce the distance "C". When the steering mechanism is working, the surfaces rubbing against each other work more when the car is moving in a straight line or turning at a small angle.

As a result of erosion of the friction surfaces of the steering mechanism, the free play of the steering wheel increases, which reduces traffic safety [1].

For this reason, one of the main requirements for the steering mechanism is the rapid restoration of worn surfaces and the ease of restoration by adjusting the free play of the steering belt. At present, to ensure easy driving, the minimum force applied to the steering wheel belt must be more than 60 N, and the maximum value must be more than 120 N (without power steering).

Steering gear types. Modern cars use worm gear steering gears.

The worm-roller steering mechanism can be used on all cars (classic layout) and trucks weighing up to 25 kN on the front steering axle without power steering and with power steering on trucks weighing up to 40 kN.

It is recommended to use a power steering gear in vehicles with a mass on the steered axle of more than 25 kN.

In a worm gear, the torque applied to the steering belt is transmitted from a worm mounted on the steering shaft through a sector to a pulley sitting on this shaft.

In most steering mechanisms, the worm is globoid (consists of a set of components of the globoid worm), and the sector teeth are replaced by a roller sitting on a bearing.

In such a steering mechanism, when the worm is rotated through a large angle, the hook is well preserved, and the wear of friction pairs is reduced.

in the screw steering mechanism, the rotational movement of the screw is converted into the translational movement of a nut made of a rack connected to the sector. The sector is fixed on one common shaft with a fork. To reduce friction in the steering mechanism and increase the strength of the connection between the screw and the nut, it is fastened with balls [2].

The number of gears in the steering mechanism of the screw-nut-sector type is determined by the ratio of the screw pitches to the initial turning radius of the sector teeth. Toothed steering gears include cylindrical or bevel gears, as well as rack and pinion steering gears. Rack and pinion steering gears consist of a gear pair and a rack and pinion.

A gear mounted on the steering shaft causes the rack to move as it rotates, and the rack acts as a transverse tensioner.

Such a steering mechanism is widely used in modern passenger cars.

Steering Gear Designs

Globoid worm roller. The steering mechanism shown in (Fig. 1) consists of a globoidal worm 5 and a roller with three sickles associated with it [3].

The worm is mounted on the connecting end of the steering shaft in a cast iron housing with two tapered bearings. In these bearings without an inner wall, its function is performed by conical surfaces on the edges of the worm.

The outer rings are installed in the crankcases, and the front and rear crankcase covers keep them from moving along the axis. Under the front cover there are several thin spacers for centering the bearings.

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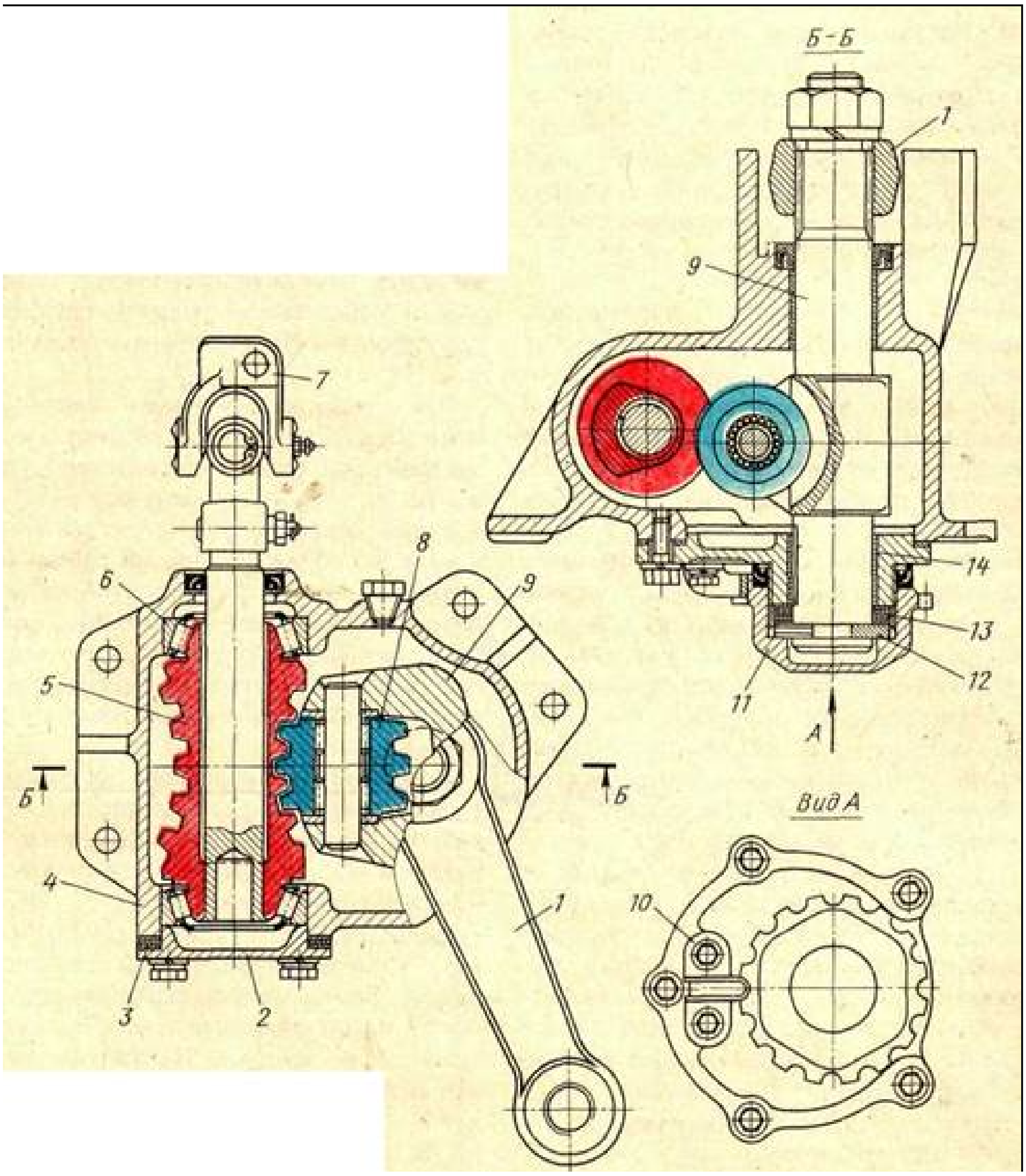

Figure 1. *Globoid worm roller steering gear*

Two roller bearings are mounted on an axle on the head of the roller shaft.

The valve shaft is installed through a window open in the side walls of the crankcase and is attached by a cover. Bushings attached to the crankcase and cover serve as a support for the camshaft.

The roller with three braids is fixed on the axis on the shaft head through two roller bearings. A polished steel washer is installed on both sides of the roller axle [4].

When the pulley shaft moves, the distance between the roller axis and the worm axis changes. This allows you to adjust the alignment gap.

At the end of the shaft there are cone-shaped cylinders to which the steering wheel is attached with a nut. At the other end of the steering shaft, an annular groove is opened, and a gasket is placed in it between the washer and the cover. This gasket serves to adjust the engagement between the roller and the worm.

A set of gaskets fixing the washer is fastened with a crankcase cover nut. The nut is tightened using stopper 10 with the bolts screwed into the cover in the desired position. The play in the steering mechanism is variable, the smallest play is when the roller is in the middle of the worm, the play increases when the steering wheel is turned to the right or left.

Such a change in the engagement slot in the steering mechanism allows the worm to repeatedly reconfigure the engagement slot in the most active middle portion, especially in the peripheral portions of the roller worm, to prevent wear [5].

Cylindrical worm and side sector. This type of steering mechanism is currently used in KrAZ-2567 and Ural-375 trucks, as well as in LiAZ-677 and LAZ-696 buses.

A cylindrical worm, pressed into the lower end of the steering shaft, is installed in a cast-iron crankcase with two tapered rollers and bearings. (fig. 2)

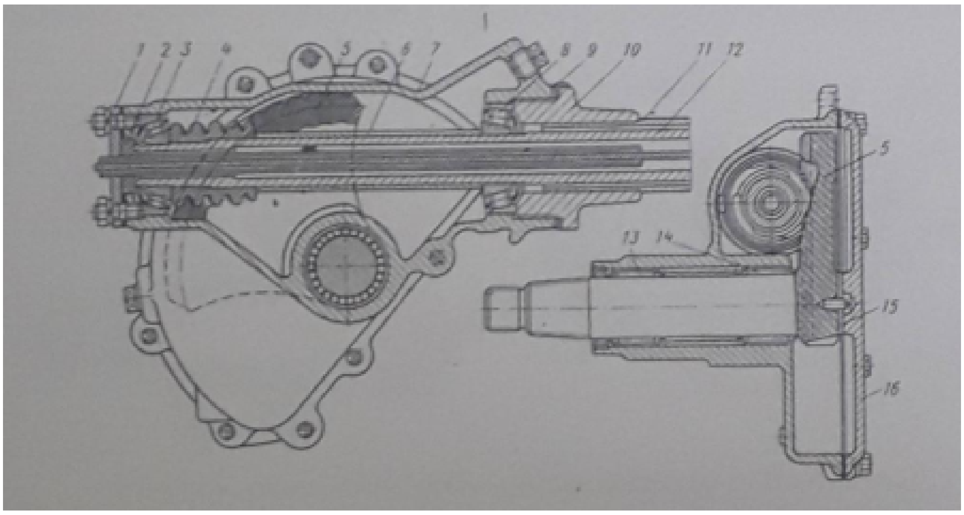

Figure 2. *Cylindrical worm and side sector steering gear*

Several shims are placed under the cover flange to keep the bearing in line.

The side sector of the helical gear adjacent to the worm is made in one piece with the shaft and rotates in the crankcase on two diamond-shaped bearings.

There is a tapered surface at the end of the shaft, and small grooves are cut into it for tightening the shaft.

The connection of the worm with the sector is designed in such a way that when the worm is in the middle position, when it turns in both directions, the gap in the connection increases.

A bronze washer of various thicknesses is installed between the side cover of the crankcase and the sector to ensure engagement of the side sector with the worm and prevent axial movement of the shaft.

Steering mechanism screw-nut, rail-sector type. Steering mechanisms of this type are currently installed on vehicles such as ZIL, KamAZ, MAZ and BelAZ.

The steering mechanism (fig. 3) consists of a screw and a ball nut, which in turn rotates with the gear wheel. The rotational movement of the screw becomes the translational movement of the rail nut. The steering gear screw is mounted on two spherical bearings inside the crankcase, which can be adjusted with a nut.

This nut is secured with a pin and a lock plate to keep it from turning on its own.

The steering gear sector is combined with 1 splined shaft and mounted on three needle bearings inside the crankcases. Adjustment of the sector shaft along the horizontal axis is carried out using a screw.

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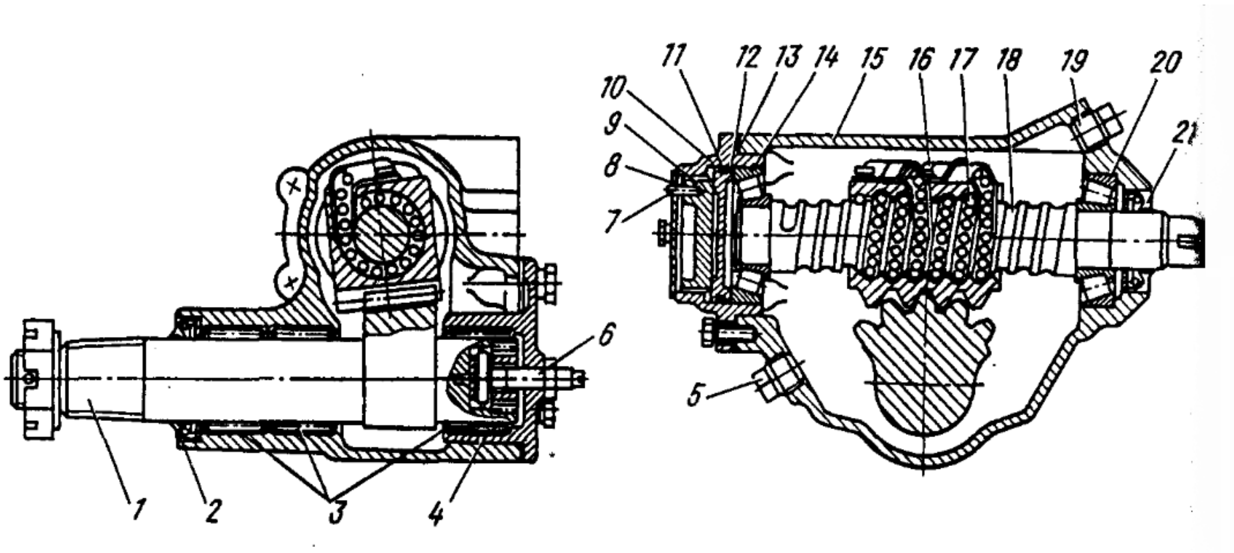

Figure 3. *Steering screw-nut, rail-sector*

Since the thickness of the teeth of the sector is uneven along the length, but has a conical shape, the engagement of the sector and the teeth of the rack is adjusted by moving the fork shaft along the axis with the help of an adjusting screw [6].

The adjusting screw is assembled with a sector shaft and screwed into the side cover of the crankcase and tightened with a lock nut. Balls located in two rows between the grooves of the screw and nut make driving easier.

To ensure continuous movement of the balls along a closed circuit, the ends of the shroud channel in which they roll are connected by two independent guide tubes.

When the screw rotates, the balls standing on the side of the nut fall onto the end of the tube, move the nut to the middle part, and then pass to the side of the nut through the grooves of the screw.

At present, on some KAZ, MAZ and KrAZ vehicles, the sector tooth is made parallel to the wheel axis in screw-nut and rack-and-pinion sector steering mechanisms.

The operation of this mechanism is carried out by twisting two inserts.

Rack and pinion steering mechanism. Such steering mechanisms are used in vehicles with a modern front-wheel drive front axle engine.

The steering mechanism converts the rotational motion of the gear on the shaft into forward and backward motion of the rail.

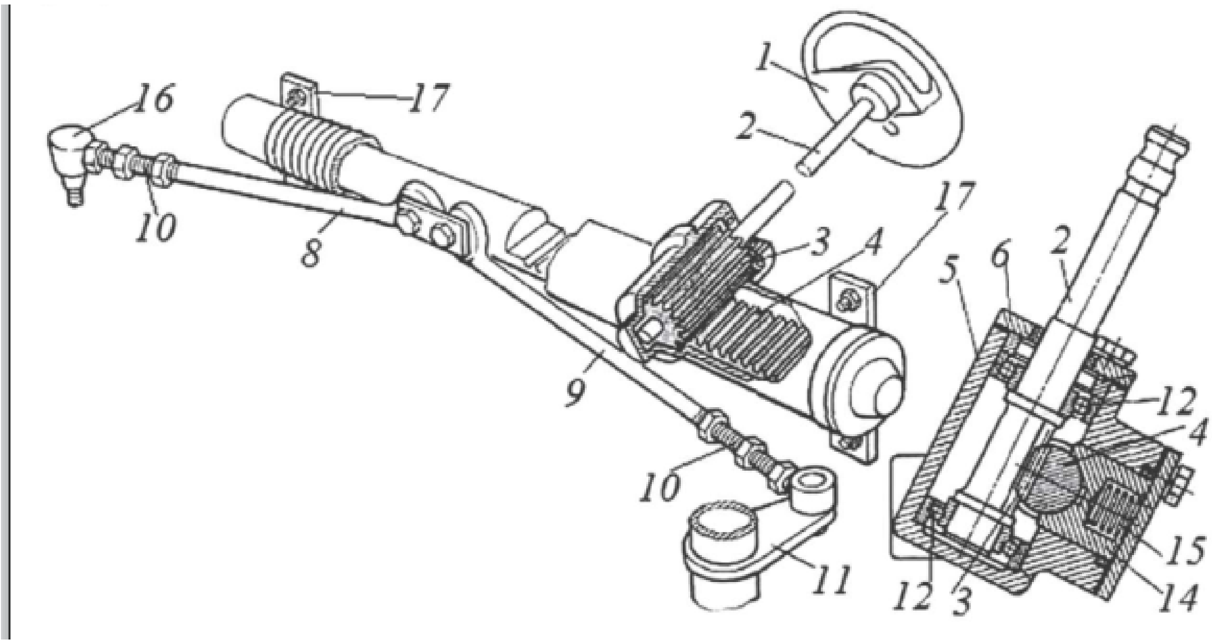

Figure 4. *Rack and pinion steering*

Turns the wheels, which are controlled by a folding towbar located next to the rail. On fig. 4 shows the design of the rack and pinion steering mechanism. When the steering belt 1 rotates, the gear moves the rack, from which power is transmitted to the steering rods. Steering racks turn the wheels controlled by steering levers [7].

The rack and pinion steering mechanism consist of a rigid gear and a rigid gear rack made with a steering shaft.

The shaft rotates on ball bearings located inside the crankcase. They are pulled with a ring and a top cover. The support is pressed against the rail by means of a spring, perceives the radial force acting on it and transfers it from the side to the cover.

Due to this, the accuracy of pair interaction is realized.

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