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KINEMATIC ANALYSIS OF MECHANISM FOR ADJUSTING THE REARVIEW MIRRORS TO ROAD VEHICLES

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Abstract: Currently carmakers in addition to developing the technical performance of road vehicles have major concerns also in order to increase comfort and safety conditions of the driver and passengers. For this purpose this paper presents the general aspects, operation and functional role of rearview mirrors with electric operated on road vehicles. The drive mechanism must provide two successive control movements with high transmission ratio in conditions of reduced dimension In this regard it was designed a transmission composed of two differential reducers, their successively operation being controlled by a clutch. In order to design gear from reducer differential structure were determined speeds, respectively gear ratio through kinematic analysis, using satellite port stop method (Willis).
Keywords: differential mechanism, satellite, satellite port arm

1. INTRODUCTION

Car current builders looking to increasing the technical performance of road vehicles, while developing avionic line, the active and passive safety elements, as well as the conditions of comfort and safety of the driver and passengers, [6].
Among the systems and equipment that are part of the "comfort", is mentioned:

- Manual / automatic heating and cooling;
- Operating windows (electric or manual);
- Rear view mirrors adjustable and heated;
- Systems audio / video;
- Electrically adjustable and heated seats;
- Manual / automatic roof hatch; convertible roof;
- Luggage carriers additional or those with special uses (skis, etc.),

which, depending on the brand of the car, for certain models contains as standard, while others are classified as optional.

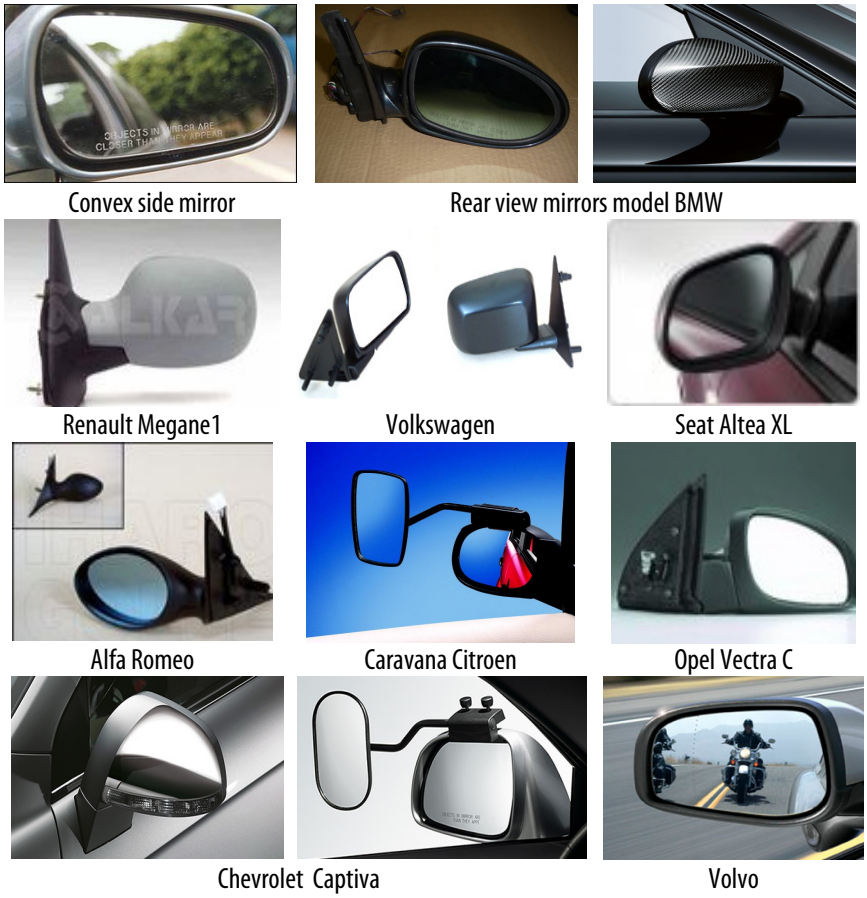

Figure 1. Side rear view mirrors models that equipping different brands and models of automobiles

Comfort increase category problems, have found solutions, mostly by designing the mechanized or automated variant of some systems such as, for example, a multi-driver seat position for optimal body position, control systems steering wheel, lifting-lowering systems for windows and electrically adjustable systems for rear view mirrors, central locking with RC systems, etc.

Currently, high and medium range vehicles frequently are equipped with rear view mirrors electrically operated, located in outside area on the front door. Order their rear view mirror side is usually integrated in the driver's door armrest and allows adjusting the mirrors position by pivoting around a two axes, until the desired orientation is obtained. For example, rear view mirrors side models that fit different brands of cars are shown in Figure 1.

2. REAR VIEW MIRRORS ROLE AND FUNCTIONS

Side rear view mirrors allow viewing some angle areas located laterally, behind the vehicle, and which are not included in the visibility area of the interior rear view mirror, as shown in Figure 2.

Figure 2. Viewing in the side rear view mirror of some areas located behind the vehicle

An improper adjustment of the position of rear view mirrors, figure 3a, jeopardizes the safe driving, according to some data on road safety, it considers that from number of traffic accidents, about 18% are caused by deviations from the lane, and the drivers who have produced such accidents, approx. 60% argued that the vehicle was not observed by them.

Correct adjustment of rear view mirrors of a vehicle, exemplified in figure 3b, ensures good visibility and minimize the so-called "dead zones" that, at the time of a deviation from the route of the vehicle, generate danger trajectory intersection either to with another trajectory road users coming from behind, from a blind area, or impact with an obstacle located in the area.

One of the methods to correctly adjust the position of the rear view mirrors, figure 3 c and d, involves the following: adjust the driver's seat to the desired position; bending head until it reaches the left window and adjusting the position of the mirror until barely see the rear bumper. Then change the driver's head position right at a similar distance (about the interior mirror) and proceed to the settings for the right mirror. Through this process of adjustment, observing objects located in viewing angles is possible without having to change the head position, and traffic from behind can be traced in the central interior rear view mirror.

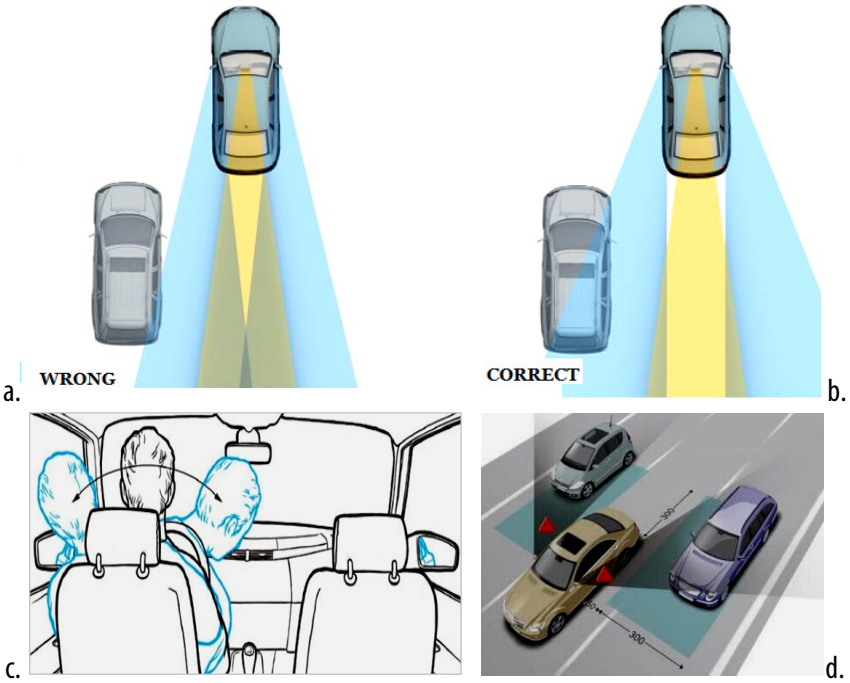

Figure 3. Visibility bands geometry generated by adjusting rear view mirrors

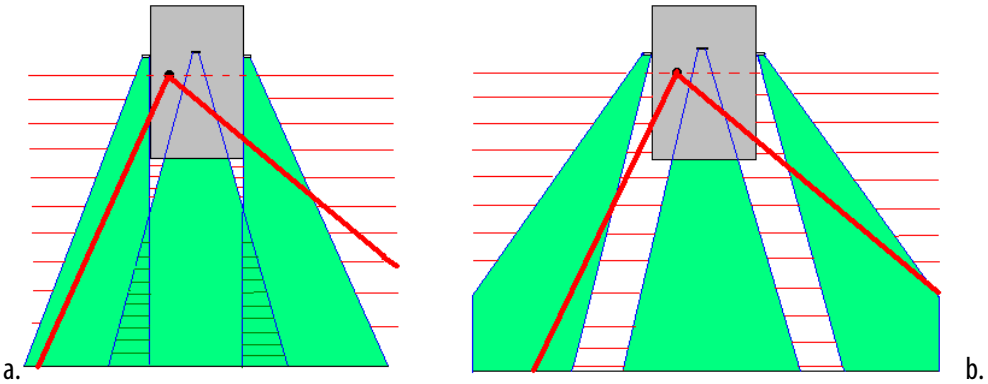

Figure 4. Visibility strips geometry variation depending on adjust side rear view mirrors

The traditional way to adjust exterior mirrors is considered the schematic from Figure 4a. It is noted overlapping zones of exterior mirrors visibility with the central inside mirror on the two shaded areas, resulting visibility angle covering an area regarded as satisfactory in terms of road safety.

In contrast, in Figure 4b, it is observed that after a further adjustment of the side mirrors, although the final areas of visibility obtained are more extensive, there are two side bands without vision, the existence of which endangers the safety of road users.

It is crucial to note that the appearance of the door mirrors are present in the majority of cases, convex mirrors and therefore image objects appear smaller and further away than they actually are. Therefore, to these types of mirrors, the manufacturer frequently enroll text warning the driver that the distance to the vehicle viewed, as it appears in the mirror is actually lower ("Objects viewed in the mirror is closer than they appear ") and therefore, what they see, not exactly correspond to reality. For this reason, some car manufacturers prefer to equip models with plane mirrors for driver and convex mirrors for passenger.

3. STRUCTURAL ANALYSIS OF THE DRIVING MECHANISM

Rearview mirror actuator is composed of two transmission reducer, and a clutch electromagnetic ordered. The two transmission reducers operate in sequence and are driven by the clutch, according to the axis about which the adjustment is made.

Because each reducers transmissions must provide a transmission ratio of i = 60, and the axes of the input and output must be coaxial, two transmissions were designed with mobile axes (planetary or differential). Kinematic scheme of the drive mechanism is shown in Figure 5.

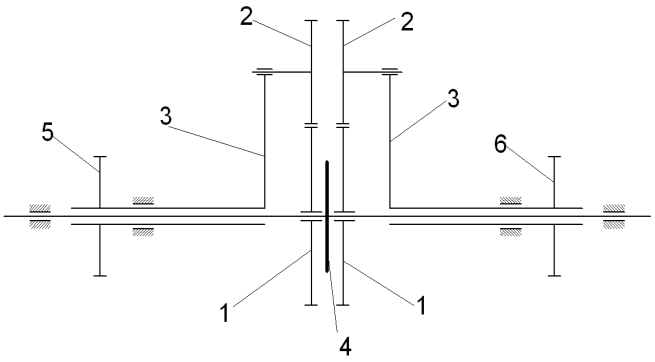

Figure 5. Kinematic scheme of the drive mechanism

The rotational movement of the electric motor is transmitted to one of the central gear (1) through the clutch (4) (depending on the desired direction for adjustment). The movement is further transmitted by the satellites (2) and the planet gear carrier arms (3), which is formed in the driven elements of the transmission with mobile axis. Satellite port arms have a tubular structure, coaxial with the input shaft, it moves having the independent rotation. On the two satellite port arms is mounted two pinions (5 and 6) of rack pinion transmissions, ensuring the two movements rear view mirror adjusters.

Next will be treat one of two transmissions mobile axis, the other being identical in every respect. Mobile axis gear kinematic scheme is shown in Figure 6.

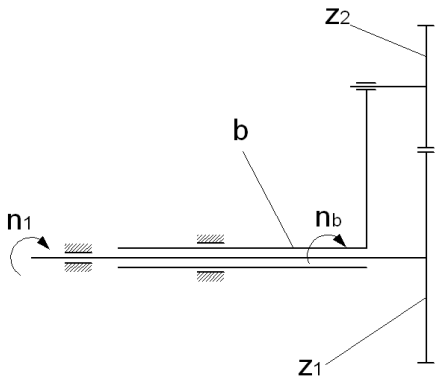

Figure 6. Mobile axis gear kinematic scheme

Gears mechanisms, ordinary or planetary are mechanisms witch have f=3 family and are composed of class 4 kinematic couplings (contact point between two teeth in gear pair) and class 5 kinematic couplings. Number of mobility degrees is determined by the relationship, [11]:

$$M_3 = 3n - 2C_5 - C_4 \qquad (1)$$

where: n - is the number of moving parts; C_5 - number of kinematic couplings of Class 5; C_4 - class 4 kinematic couplings number.

For the mechanism of Figure 6, is considered that the central wheel 1 is the driving one and the arm b is the driven element, respectively:

$$n = 3\ ;\ C_5 = 3\ ;\ [(0;1),(0;b),(2;b)]\ ;\ C_4 = 1;[(1;2)]\ ;$$
$$M_3 = 3\cdot 3 - 2\cdot 3 - 1\cdot 1 = 2$$

so the mechanism is differential.

4. KINEMATIC ANALYSIS OF THE DIFFERENTIAL REDUCER

Kinematics planetary mechanisms aims to determine the transmission ratio also the speed of gears who composing mechanism. Universal method of kinematic study of planetary mechanisms is arm off method, *(Willis)*. To study the real mechanism kinematic is necessary to convert it into an equivalent mechanism with fixed axis, whose study is already known, [1, 7, 10].

The arm stop method consists in the fact that in the imaginary way to entire assembly of the mechanism is give a speed $-n_B$, opposite satellite port arm speed around its axis of rotation. In this way, the arm will have zero speed, planetary gear has become an ordinary one, which can be studied by known methods. Thus, for the differential mechanism with kinematic scheme in Figure 6, we can write, [1, 7, 10]:

$$i_{12}^{b} = \frac{n_1 - n_b}{n_2 - n_b} = -\frac{z_2}{z_1} \qquad (2)$$

With the values imposed by the design theme, respectively: $n_1 = 600$ rev / min electric motor speed and $i = 60$ - the transmission ratio of the differential gear, satellite port arm speed, n_b determined by equation (3).

$$n_b = \frac{n_1}{i} = \frac{600}{60} = 10\,\text{rot/min} \tag{3}$$

By adopting constructive, from conditions of size, the number of teeth of the two gears: $z_1 = 10$ and $z_2 = 16$, transmission ratio under the terms of stop the arm port satellite, respectively satellite speed were determined as follows:

$$i_{12}^{b} = \frac{z_2}{z_1} = \frac{16}{10} = 1{,}6\,; \qquad \frac{600-10}{n_2-10} = -\frac{16}{10} \Rightarrow n_2 = -\frac{5900}{16} + 10 = -358{,}75\,\text{rot/min} \tag{4}$$

5. CONCLUSION

Adjust the rear view mirrors electric drive from motor vehicles is a security and comfort element of the driver or passengers. Because of reduced conditions of sizes and in conditions of high transmission ratio, it was designed a drive mechanism consisting of two differential reducers, each of the two independent adjustments. Differential reduction gears kinematic analysis was performed by satellite port arm stop method, aimed to determining the specific characteristics of the transmission power, so as to ensure the possibility of rotations rear view mirror around two axes.

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