MECHANISMS USED FOR DRIVING WINDOWS OF CAR SIDE DOORS

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Abstract: The paper presents the main types of the mechanisms used for opening and closing of windows on the car doors. It is identified the three types of the mechanisms used as “crane” for the door windows: the mechanism with bars and gears, the mechanism with cable and the mechanism with elastic rack.

Keywords: “crane” mechanism, door window, bars, gears, cable, elastic rack.

1. GENERAL ASPECTS

For sliding of the windows on the car side doors there are used the so-called “crane” mechanism of side windows [2]. This mechanism allows the raising (closing) and lowering (opening) respectively of car side door window.

Usually, the window of the car side door has got a rectilinear translation (fig. 1a) or, in the case of some modern cars [1,4], the displacement of window is a curved translation (fig. 1b).

![Fig. 1. Displacement of door window:

a) Rectilinеar translation on line ($\Delta A$);

b) Curved translation on curve ($\Gamma A$).

On classical cars, these mechanisms are driven only manually with the hand crank, while on the modern cars the driving is both manual and electrical, through distance control.

The sliding of the window in the direction of the displacement is achieved in a rubber guide, which is fixed in the metal frame of the car side door.

The window is guided by a rubber frame, which is fixed in a metal support (fig. 2).
This guide has at its lower side one or two horizontal (fig. 2a) or inclined (fig. 2b) openings.

The support in which the window „crane” mechanism is mounted lies in the internal panel of the door, this panel being achieved in a frame shape [2].

The base plate of the window mechanism is fixed; to this frame has got an aperture through which out the drive shaft goes. This shaft has a crank fixed to it.

The driving force of the „crane” mechanism, for raising the window, must not exceed the value of 15 kN. In the case of the electrical action, this is achieved with an electromotor with a small gauge, which is supplied with 12V d. c. from the accumulator battery.

In the following, there are presented some types of construction schemas of „crane” of the mobile windows, from among which mention is made of: the bar and cylindrical gearing mechanism, the mechanism with elastic rack and the mechanism with cable and guide rollers.

2. PLANAR MECHANISM WITH BARS AND GEARS

From among the types of planar mechanisms with articulated bars, the most widely used is the four bar linkage, the crank - rocker type (fig. 3) or parallelogram linkage type [3], such as the mechanism used on the Dacia car [2].

The crank 2 has a geared segment, attached to it, where the latter has $z_2$ teeth. The geared segment is in gearing with the pinion 1, with $z_1$ teeth. On the pinion shaft 1 there is fixed the hand crank for driving the mechanism.

![Fig. 3. Constructive schema of planar mechanism for window displacement, achieved with spur cylindrical gearing and four bar linkage crank-rocker type.](image)

The bar 3 represents the connecting rod in the linkage quadrilateral $A_0ABB_0$ and is prolonged with the segment BC.

A portion from the path of point C is used for the displacement of the window frame 5 in the direction of opening / closing the window. The connection between the bar 3 and the window frame 5 is achieved with a high joint of rotation - translation [3].
The rocker 4 is articulated at base in $B_0$ and swings between two limit positions, which correspond to the extreme positions of (open / close) window.

The constructive schema (fig. 3) presents the lower (open) position of the side door window. The disadvantage of this solution is that then the frame 5 starts hoist together with the window, the former tends to occupy an oblique position against the vertical guide, and the mechanism is blocked. The length of the groove inside frame 5 corresponds to raising (closing) the window, such that in the top position, the point C of applying the raising force is placed at the middle point of the window width.

The spur cylindrical gearing (made up of pinion 1 and gear sector 2) is placed behind bar 4 and the pinion 1 axis is on the left of the fixed joint $A_0$ and above the other fixed joint $B_0$. In this way, the support plate of the “crane” mechanism has a smaller gauge.

The number of evolving teeth of pinion 1 is $z_1 = 6...12$, and for the gear sector 2 the number of teeth can be $z_2^* = 35...90$, in proportion to $\alpha$ angle at the circular sector, whose values are $\alpha = 90^0$ ...$180^0$.

In the case of the above mechanism (fig. 3), the gear sector 2 has the angle $\alpha = 180^0$ and the number of teeth is $z_2^* = 90$. The cylindrical gearing achieves a reduction, where the transmission ratio from pinion 1 to the gear sector 2 being $i_{12} = - \frac{z_2^*}{z_1}$.

A variant of the bar mechanism is the one using the crank-slider mechanism (fig. 4), where the slider is replaced by a high rotation-translation pair which guides the connecting rod 3 through a bolt inside a horizontal fixed guide.

![Fig. 4. Constructive schema of crank-slider mechanism type](image-url)
Typical of this bar mechanism of a crank-slider type (fig. 4) is the fact of the crank length $A_0A$ being equal to the AB length of connecting rod 3.

Both the connecting rod 3 and the crank 2 are extended with the same length, that is, segment AC is equal to AD, which makes the straight line defined by the points C and D be parallel to $A_0B$, that is the horizontal position.

The bar 4 has a translation movement along a vertical line, that is perpendicular to the fixed guide of point B, center of the bolt or of the roller at the end of the connecting rod AB.

The spur cylindrical gear is a reducer, being formed by the pinion 1 (cu $z_1 = 6...8$ teeth) and a gear sector (with the angle of $90^\circ ...100^\circ$ at the center of the gear crown). The sector is solid with the crank 2 and has $z_2$ teeth, where $z_2 = z_2' + z_2'' = 40...45$ teeth.

3. MECHANISM WITH PINION AND HELICAL SPRING - ELASTIC RACK

These mechanisms are the most simple, having only two mobile elements (fig. 5): the drive pinion 1 and the elastic rack 2 as a driven element.

This special rack is under the form of a helical spring (fig. 5a), having inside a synthetic core. The helical spring has a proper stiffness so that it doesn’t modify its pitch, operating as a rack. The synthetic core is impregnated with mineral oil, through which the lubrication of the gear-rack gearing is ensured.

![Fig. 5a. Constructive schema of pinion and helical spring – elastic rack mechanism](image-url)
The elastic rack is guided by a fixed metal tube 0, in the shape of letter S, provided with a longitudinal slit and makes the opening ends.

The rod 3 is horizontally connected on these open parts in the points C and D (fig. 5), the rod being provided with a supporting frame for the door mobile window.

By choosing the S-shaped path of the elastic rack 2, the two points C and D of the (helical spring) rack move in the same direction on a vertical line, which allows bar 3 to be maintained in a horizontal position and also achieves a translation movement of the window.

The overall length of the metal tube 0 is longer than the length elastic rack 2 with approximately the value of the maximal opening stroke of the side door window.

Besides the casing of the pinion – rack - gearing, the metal tube 0 is also fixed to the side door girder in at least other four points (fig. 5).

A variant of the elastic rack mechanism uses the metal tube with the opened loop in the shape of letter U (fig. 6), so that the window is supported on one single point C, on the right side of the tube.

![Fig. 6. Constructive schema of the windows displacement mechanism (rotated with 90°); this is achieved with the pinion and the elastic rack in U shape, variant 1.](image)

The line of the tube is fixed in two points D and E (fig. 6) on the door girder. In order to reduce the gauge of this mechanism, the metal tube extends to the other side of the pinion-rack gearing, with a rubber hose, having its free end on the support in D.

The casing 0 of the pinion 1 – elastic rack 2 gearing (fig. 6) allows for a gearing along a longer length, which ensures the transmission of a higher force through the helical spring to the mobile window.

A second variant of the window drive mechanism which has one single support (fig. 7) uses the pinion 1 – rack 2 gearing with a smaller continuity degree.
In the part of maximum curving F, the tube is replaced by a special casting between the curved and linear parts. Beyond the gear-rack gearing (1, 2), the tube extends through a rubber segment for the helical spring to penetrate into this part when the window descends to its lower limit given by point E.

4. CABLE AND ROLLER MECHANISM

As a topological structure, this mechanism is the most simple, having a shaft provided with a cylinder 1 round which the metal cable 2 winds (fig. 8).

Under normal conditions (steel on steel) the cable 2 has 4 - 6 windings round the drive shaft 1 (fig. 8). In order to protect the metal cable, its two branches pass through plastic tubes. When coming out of these tubes, the cable passes over two rollers, after which the cable becomes rectilinear between the 2 rollers, between points C and D (fig. 8).
Cable 2 winds round the shaft 1 (fig. 8), through with the displacement of the window supported on the support 2’ (solid with cable 2) is performed manually or through the control of a d. c. electric motor. The number of windings of cable 2 on the shaft 1 must be sufficiently to stop the two surfaces slide on each other (one cylindrical and the other ring-shaped).

REFERENCES

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