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KINEMATIC SYNTHESIS OF NEEDLE MECHANISM OF SEWING MACHINE AND ITS SIMULATION USING SOLIDWORKS MOTION

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The optimal design of mechanisms of sewing machines is an important practical task, because by means of kinematic synthesis methods it is possible to obtain various kinematic characteristics of their points and links, in particular, the laws of motion of the output link – the needle guide, including the values of displacements, velocities and accelerations. As it is known, the needle mechanism of a sewing machine performs the following functions: piercing and passing threads through the material, forming a loop and tightening the stitch. Moreover, depending on the purpose of the sewing machine, the needle can perform a simple movement (straight-line or curvilinear), as well as a complex planar or spatial movement.

For example, the 876 class sewing machine uses an eight-link linkage mechanism, the structural scheme of which is shown in the Fig. 1. According to the Assur classification, this linkage mechanism consists of a ground link to which crank 1 (mechanism of the 1st class) is connected in series, besides – two groups of the 2nd class of the 1st type (links 2–3 and 4–5, respectively) and one group of the 2nd class of the 2nd type (links 6–7).

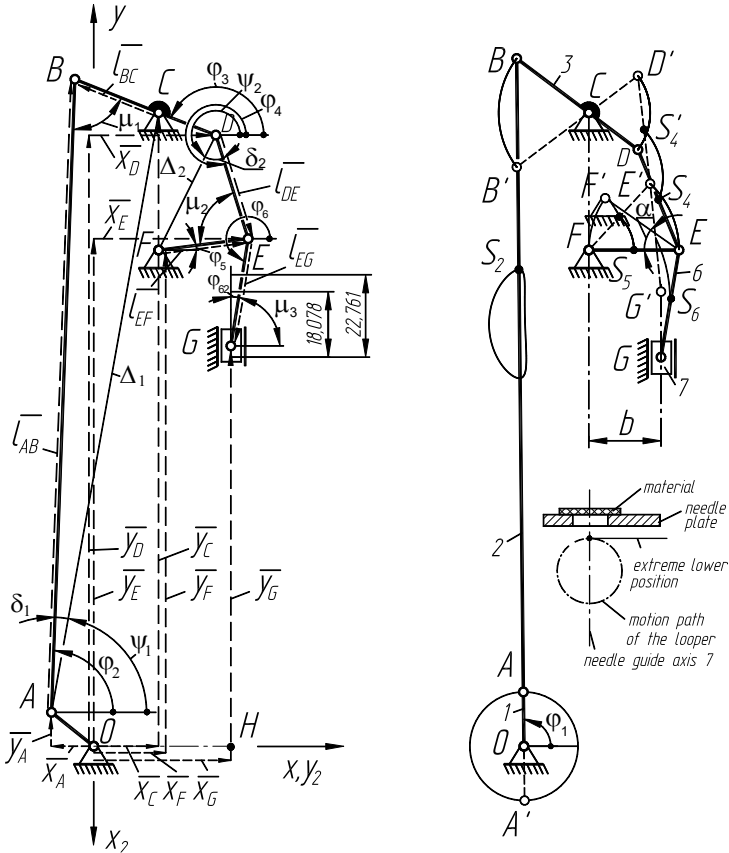


Fig. 1. Kinematic scheme of the mechanism:
a) calculation scheme; b) mechanism in extreme positions
with trajectories of movement of individual points

The needle installed on the needle guide 7 makes a reciprocating movement, the maximum stroke of which is 36 mm. Practically all types of mechanisms of such machines have an unregulated movement of the needle, including the 876 class machine. This mechanism can be upgraded if the stroke of the needle could be adjustable, which can be done by changing the position of the fixed hinge F (Fig. 2). For the normal stitch formation conditions, the lower position of the needle should remain unchanged (Fig. 2, b).

So, the aim of the work is designing of the mechanism of the needle guide of the sewing machine in order to regulate the movement of

the needle within the specified limits, as well as its research in order to determine its main kinematic characteristics and working capacity.

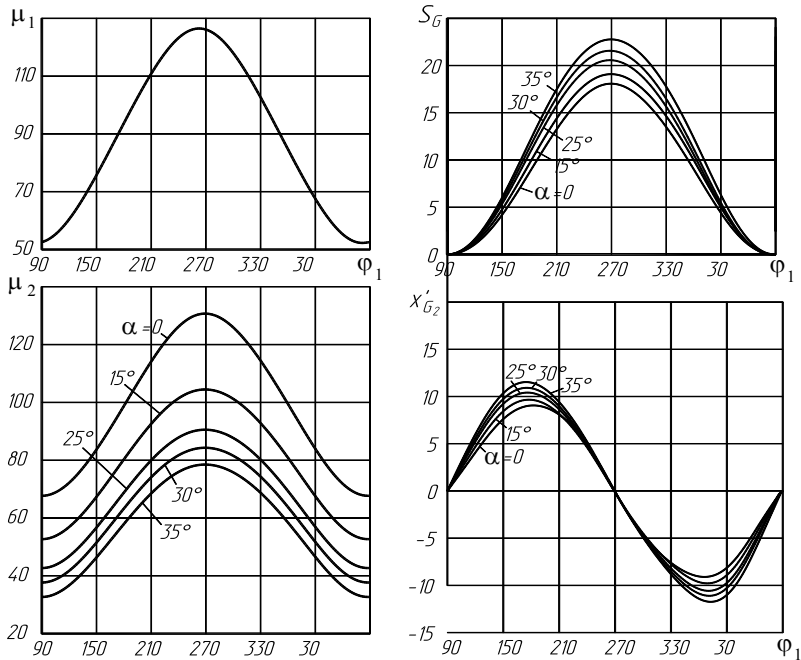


Fig. 2. Results of the kinematic analysis

The problem of optimal kinematic synthesis of linkage mechanisms is one of the most difficult problems in the theory of mechanisms and machines. There are a number of tasks for the kinematic synthesis that require designing such mechanisms according to various criteria, in particular, according to the given law of motion of the output link or the by the maximum value of the output link displacement [1–5].

After conducting the kinematic synthesis, it is also necessary to carry out kinematic analysis of the designed mechanisms and perform an optimization procedure. Let's consider the sewing machine mechanism, the structural scheme of which is shown in the Fig. 2. The dimensions of the links of the mechanism are as follows: $l_{OA} = 15$ mm, $l_{AB} = 175$ mm, $l_{BC} = 25$ mm, $l_{CD} = 17$ mm, $l_{DE} = 30$ mm, $l_{EF} = 25$ mm, $l_{EG} = 30$ mm, $x_{OF} = 18$ mm, $b = 20$ mm. The kinematic parameters of the output link of

the mechanism were defined using the known analytical methods [1, 2]. During the research process, it was established that the mechanism has two extreme positions that are in the positions of the crank that are defined by the angles $\varphi_1 = \varphi_0$ and $\varphi_1 = \varphi'_0$. Then, it is obvious that the stroke of the slider 7 can be determined as follows:

$$S = y_G(\varphi'_0) - y_G(\varphi_0).$$

The results of the performed calculations are presented below. As can be seen from the diagrams in the Fig. 2, with an increase of the value of the angle α , that determines the position of the fixed hinge F , the stroke of the slider 7 increases, and the lower position of the slider remains unchanged. Another dependence is also observed – with the increase in the stroke S_G of the output link, the analogs of velocities and accelerations also increase.

In order to check the correctness of the obtained analytical formulas and the operability of the proposed mechanisms with adjustable stroke of the needle, a computer simulation of the sewing machine needle guide mechanism was carried out in the Computer-Aided Design system SOLIDWORKS, and the kinematic characteristics of the mechanisms were determined using Computer-Aided Engineering system SOLIDWORKS Motion (Fig. 3).

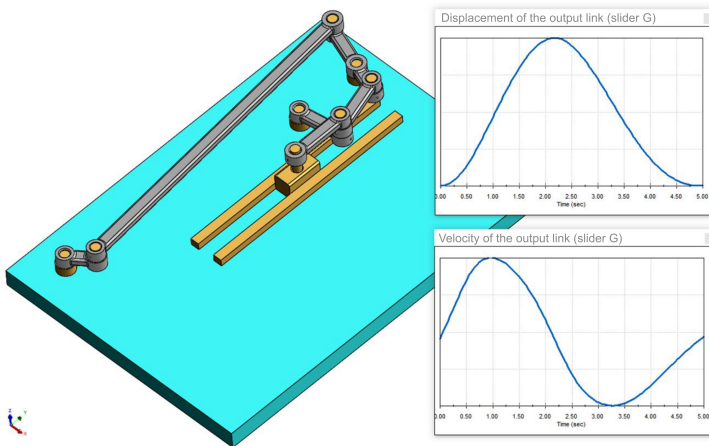


Fig. 3. Mechanism and results of calculation in SOLIDWORKS Motion: displacement and velocity of the output link

Conclusions. It was established an expediency of adjusting of the stroke of the slider 7 only within such limits as: $0 < \alpha < 35^\circ$, taking into

account the permissible values of transmission angles. Further increase of the angle α will lead to jamming of the mechanism links. As a result of the study, it was established that the stroke of the needle guide 7 can be adjusted in the range from 18 to 23 mm. The conducted computer modeling and corresponding kinematic analysis in SOLIDWORKS Motion confirmed the correctness of the analytical calculations and the operability of the proposed mechanisms.

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СТАН ПРОБЛЕМИ ЕКСЦЕНТРИСИТЕТУ РОТОРА СУЧАСНИХ АСИНХРОННИХ ЕЛЕКТРИЧНИХ МАШИН

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Асинхронні електричні машини (АМ), зокрема асинхронні електричні двигуни (АД) є найпоширенішими електричними машинами. АД споживають понад 80 % електроенергії, що виробляється електростанціями України. Дефекти і несправності у двигуні прогресують у процесі експлуатації, викликаючи зношування справних частин, а також спряжених машин і механізмів. Відмова АД спричиняє значні економічні витрати, тому проблема надійності АМ є актуальною.

Для АМ в якості опор ротора використовують підшипники, закріплені у спеціальних стояках. Стояки болтами прикріплюються до нижньої половини торцевого щита. Відмови підшипників АМ складають близько 40 % від загальної кількості відмов асинхронних машин [1, 2]. Вихід з ладу підшипників в основному викликаний їх підвище-