ACTUAL PROBLEMS OF MODERN SCIENCE

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CONTENT

MECHANISMS WITH VARIABLE LENGTH OF LINKS FOR DRIVE GUIDE NEEDLES OF KNITTING MACHINES

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1. Introduction

Multi-link hinged-beam mechanisms of the second and higher classes according to the Assura classification are widely used in high-speed knitting machines for the drive of looping organs. Such mechanisms ensure, in a certain approximation, the reproduction by the working organs of complex laws of motion, including stops, during the looping cycle. At the same time, in order to increase the accuracy of reproduction of complex laws of motion of working organs, eight, ten and twelve-link structures of mechanisms, as well as mechanisms with several degrees of freedom are widely used. The minimum number of links in the mechanism, which can be implemented stopping the working organ of the desired duration, should be greater than six [1].

The possibilities of hinged-beam mechanisms with "rigid" links, which are formed by stable scheme, are in a sense exhausted [2]. Therefore, the urgent task is to create mechanisms of variable structure with variable metric parameters and the shape of the links. This allows to reduce the number of moving links in the mechanism while maintaining the technological process and open new perspectives for the creation of new technological processes [2]. In these mechanisms, the kinematic scheme changes independently in the required way during the loop formation cycle due to the change in the length of the links, the shape of the links, the type of kinematic pairs, and the degree of mobility of the mechanism.

2. Research results

The expediency of using four-link mechanisms of variable structure to drive the working organs of technological machines in the industry is proven by examples of the use of similar mechanisms with elastic links in sewing machines and knitting machines [1, 3, 4, 5, 6, 7, 8, 9].

An 8-link mechanism of oscillating motion of auricular needles with rotating kinematic pairs was used as a basic mechanism for research [1]. In this mechanism a comb with auricular needles performs reciprocating oscillating motion according

to the law “forward oscillation - displacement before needle hooks - backward oscillation - displacement behind the backs of needles. The offset behind the backs of the needles in the warp knitting (WK) machine occurs when stopping the combs with eye needles, the duration of which ($\varphi_{pr} = \psi 1$) which depends on the WK machine and is approximately ⅓ loop looping (≈ 120 ° angle of rotation of the leading link) (Fig. 1).

The authors of several structures of mechanisms of variable structure are offered as the driving mechanism of working organs of looping of basic knitting machines.

One of such mechanisms is a four-link mechanism with a variable type of kinematic pair, in which the structure changes at certain phase angles of the leading link, ie when laying the warp threads the mechanism is crank-and-rocker, and when performing other stages of the looping process - slider-crank mechanism.

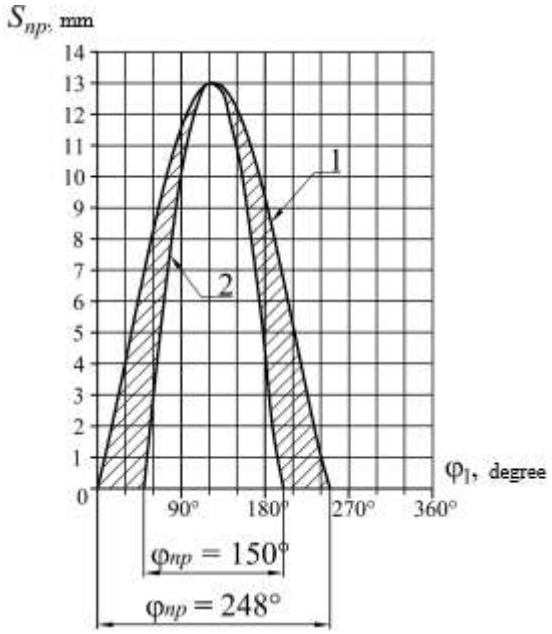

Fig. 1. Combined graphs of movements of the guide needle: the basic WK-machine (curve 1) and according to the typical cyclogram of the WK-machine (curve 2)

At the phase angles of oscillation of the guide needles the rocker arm has a constant length, and at the phase angle of the stop - its movement is limited by a fixed stop. Due to the change in the length and shape of the rocker arm of the mechanism, it is possible to turn when stopping the auricle needles in accordance with the law of motion in Fig. 1.

The block diagram in Fig. 2 contains a leading link fixed on the main shaft 1

- an eccentric 2, a con-rod 3 and a link 4, which at certain phase angles of the main shaft moves as a slider or as a rocker arm. The link 4 sliding part 5 forms a translational kinematic pair with a fixed guide 6, which is made with a cylindrical head. Link 4 guide part 10 and roller 9 can be connected to the shaft of the guide combs 7. On the shaft 7 is fixed to the holder 8 of the guide combs 9. When the mechanism at certain phase angles of the drive link 1, the link 4 interacts with the stop 12. In Fig. 2 does not show the mechanism of displacement of the guide combs.

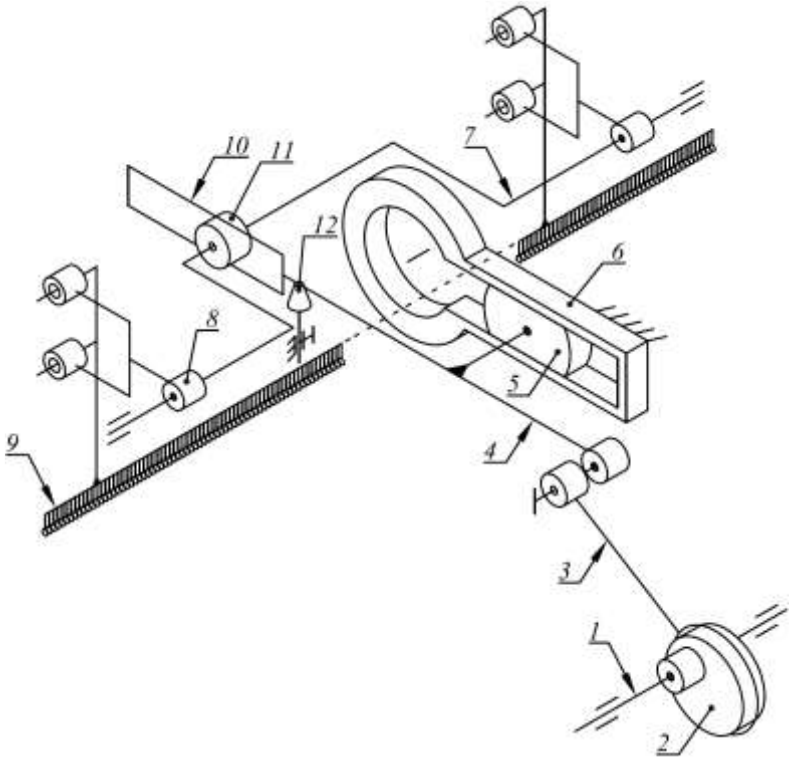

Fig. 2. Block diagram of the mechanism of oscillating movement of the guide needles of the warp knitting machine with a changing kinematic pair

When operating the mechanism from the initial (zero) position, which is taken as the beginning of the oscillation of the guide combs forward, the link 4 sliding part 5 forms a rotating kinematic pair with a cylindrical head of a fixed guide 6. The mechanism works as a crank. The oscillating movement back and forth is transmitted to the shaft 7 with guide combs 9. In this case, the laying of the warp threads on the hook needles.

During the interaction of the stop 12 with the link 4, the latter stops its oscillating motion. With further movement of the leading link there is a change in the kinematic scheme due to a change in the type of kinematic pair: the sliding part

5 of the link 4 moves along a fixed guide 6 and the mechanism becomes a slider-crank. During the stop of the oscillating movement of the link 4 and together with it the guide combs 9, the shear mechanism shifts the guide combs along the front part of the WK-machine.

The next of the mechanisms of variable structure, which is proposed for use in WK-machines, is a four-link mechanism with an elastic con-rod, which at the phase angles of oscillation of the guide comb works as a crank-and-rocker mechanism, and at the phase angles of the stop - as a oscillaiting crank gear (Fig. 3) .

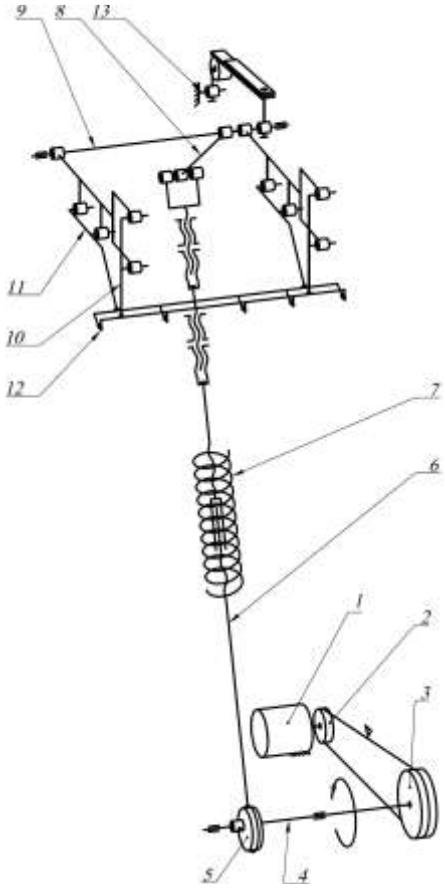

Fig. 3. Block diagram of the mechanism of oscillating movement of the guide needles with an elastic con-rod of the warp knitting machine

Synthesized for the mechanism of oscillating motion of the guide needles of the WK-machine block diagram (Fig.3) contains a fixed on the main shaft 1 drive link - eccentric 5, rocker arm8 and link 6, which at certain phase angles of the main shaft moves as a connecting rod or splits into two links, one of which moves as slider, the other – as alink. Link 6 consists of two parts, which are connected by an elastic element 7. The rocker arm 8 is attached to the shaft of the combs 9, on

which the holder is fixed by the combs 10 and 11. During operation of the mechanism at certain phase angles of the leading link 1 is the interaction of the rocker arm 8 with the stop 12.

During the operation of the mechanism from the initial position of the link 6 works as a con-rod and transmits the movement of the rocker arm 8. The mechanism works as a crank-and-rocker; the oscillating movement back and forth is transmitted to the shaft 9 with guide combs10 and 11. This is laying the warp threads on the hook needles.

During the interaction of the stop13 with the rocker arm 8, the latter stops its oscillating motion. With further movement of the leading link there is a change in the kinematic scheme of the mechanism - one part of the link 6 turns into a con-rod, the other - into a rocker arm, so that with further rotation of the leading link 5 the mechanism does not lose the ability to rotate. During the stopping of the oscillating movement of the rocker arm 8 and together with it the guide combs 10 and 11, the shear mechanism shifts the guide combs along the front part of the WK-machine.

The next of the mechanisms of variable structure, which is proposed for use in WK-machines, is a four-link with variable length rocker arm and riser, in which the structure remains unchanged at certain phase angles of the leading link, ie the mechanism remains crank-and-rocker, and the kinematic scheme of the mechanism changes.

The structural scheme synthesized for the mechanism of oscillating movement of the guide needles of the WK-machine (Fig. 4) contains the leading link fixed on the main shaft 1 - the eccentric 2, the con-rod 3 and the rocker arm consisting of two parts 4 and 5. The two parts of the rocker arm 4 and 5 form a rotating kinematic pair and are pressed against each other by stops 7 and 8 by means of a torsion spring 6 which connects the two parts of the rocker arm 4 and 5. The second part of the rocker arm 5 is fixed on the shaft 9 of guide combs. On the shaft 9 is fixed to the holder of the guide combs 12, which forms a translational cylindrical kinematic pair 13 with guide combs 14. When operating the mechanism at certain phase angles of the drive link 1, the second part of the rocker arm 5 interacts with the stop 11.

When the mechanism works from the initial position, the two parts of the rocker arm 4 and 5 are pressed against each other and work as one rigid link - the

rocker arm. In this case, the oscillating motion at an angle ψ_1 back and forth is transmitted to the shaft of the guide combs 9 and the guide combs 14.

During the interaction of the stop 10 of the second part of the rocker arm 5 with the fixed stop 11, the second part of the rocker arm 5 stops its movement. At the further movement of a leading link there is a change of the kinematic scheme, namely, lengths of a riser and a rocker arm change. The role of the riser is now performed by the stopped second part of the rocker arm 5, and the role of the rocker arm is performed by the first part of the rocker arm 4, which oscillates at an angle ψ_2. During the stopping of the second part of the rocker arm 5 and together with it the guide combs, the shear mechanism shifts the guide combs along the front part of the WK-machine. Then, under the action of the torsion spring 6, the two parts of the rocker arm are connected and work as one rigid link, and the movement is again transmitted to the guide combs 14.

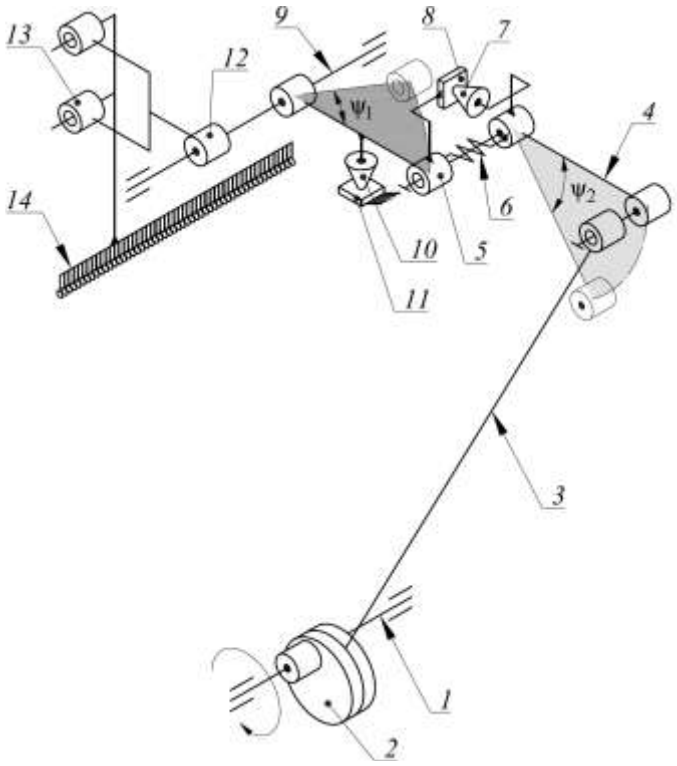

Fig. 4. Block diagram of the mechanism of oscillating movement of guide needles with variable length of the rocker arm of the warp knitting machine

The next of the mechanisms of variable structure, which is proposed for use in WK-machines - a four-link mechanism with a folded connecting rod "breakable" (Fig. 5).

During operation of the mechanism during the oscillation of the guide combs 15, the two parts of the folded con-rod 3 and 8 are pressed together by an elastic element 5 and work as one rigid link - the con-rod. When stopping the guide combs, when the rocker arm 9 interacts with the stop 11 and turns into a riser, part 3 of the folded con-rod works as a con-rod, and its other part 8 - as a rocker arm.

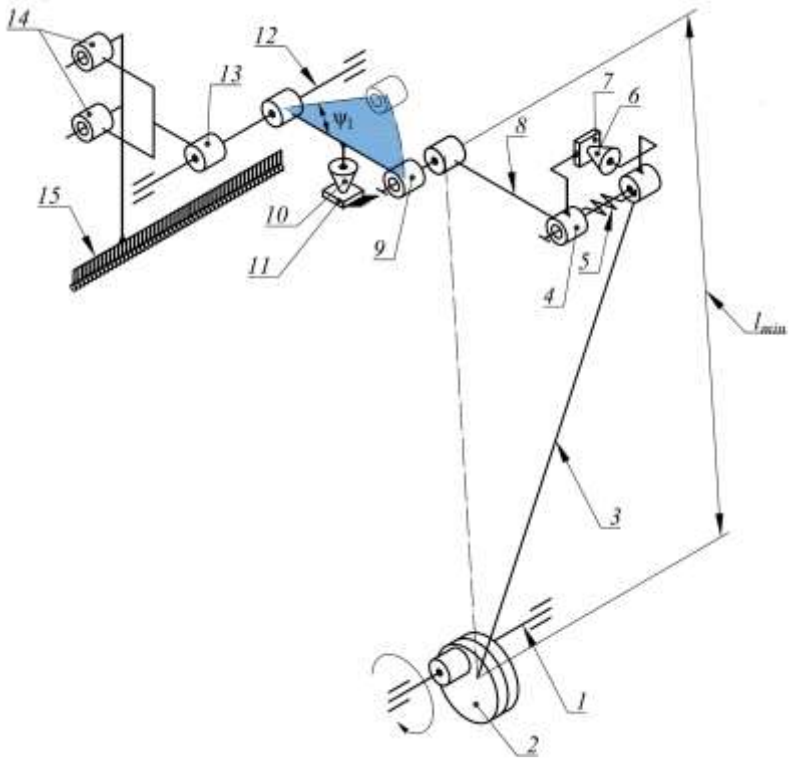

Fig.5. Block diagram of the mechanism of oscillating motion of the guide needles with a variable length of the con-rod of the WK-machine

To determine the geometric parameters of the structural scheme of the above mechanisms of variable structure, which satisfy the necessary kinematic, dynamic and structural features of the mechanism, it is necessary to perform a metric synthesis. The kinematic conditions are the given maximum value of the angle of oscillating motion of the guide needles ψ and the given angles of rotation of the main shaft φ_i, at which the forward, backward movements and stopping of the guide needles take place. The value of the angle ψ depends on the type of needles with which the warp knitting machine is equipped and the number of combs with guide needles. The dynamic condition is the observance of the admissible pressure angles in the kinematic pairs θi. The design conditions are a given distance AD between the main shaft and the oscillation shaft of the guide needles, the nominal

length of the rocker arm *CD* and the coordinates of the stop.

The peculiarities of the mechanism of oscillating movement of guide needles with variable links are the conversion of the leading link into oscillating movement with stopping the combs with guide needles while providing forward and backward oscillation at an angle ψ when rotating the leading link at an angle φ_{3_1} and angle φ_{1_2} position when rotating the leading link at an angle φ_{2_3}. The pressure angles that determine the efficiency of the mechanism should not exceed the allowable values.

It is known that the angles of rotation of the slave link ψ and the drive link φ of the hinged four-link *ABCD* are interconnected by the dependence $\psi = f(\varphi)$. In this case, taking into account the specifics of the structure of the mechanism of the guide needles with variable links, this dependence can be used only in the phases of forward and backward movement of the guide needles. During the stop it is necessary to take into account the change in the length and shape of the variable link (crank, con-rod, rocker arm) during the looping cycle.

For example, if the variable link in the mechanism is a rocker arm, then in the phases of forward and backward movement the mechanism can be considered as a mechanism of a hinged four-link, and in the stopping phases - as a oscillaiting crank gear in which one part of the variable rocker arm acts as a fixed guide. and the other is a backstage slider. That is, a mechanism with a variable kinematic structure is used.

In the synthesis of the mechanism of guide needles with a variable link, the extreme upper position (phase of shift in front of the needle hooks) and two intermediate positions (stop phase behind the backs of the needles) are known, which is the specificity of the synthesis.

Take the length of the crank $r = l_{AB}$ and the length of the con-rod $l = l_{BC}$ for the parameters to be determined during the synthesis. We set the parameters that can be changed during the synthesis: l_{AD} - the distance between the axes of the crank and rocker arm; l_{CD} - the length of the rocker arm; γ_1- the initial angle of installation of the rocker arm; $\Delta\varphi$- the angle between AC_1 and AC_2; $\Delta\varphi = \frac{\varphi_{3\_1} - \varphi_{1\_2}}{2}$.

3. Conclusion.

Using the recommendations [1, 10, 11, 12, 2], we compose expressions to determine the lengths of the crank *r* and the con-rod *l*:

$$r = \frac{l_{AC1}^2 - l_{AC2}^2}{2 \cdot \left(l_{AC1} - l_{AC2} \cdot \cos\left(\varphi_{1\_2} + \Delta\varphi\right)\right)}; \qquad l = l_{AC1} - r. \tag{1}$$

When constructing the mechanism according to the calculated values of the parameters, it may turn out that it will not meet the specified angles of rotation of the crank when moving forward and when stopping the guide needles with satisfactory reproduction of the angle of rotation of the crank, which corresponds to the backward movement of the guide needles. Therefore it is necessary to compare the value of one of the specified angles of rotation of the crank (φ_{2_3} or φ_{3_1}), the value calculated by certain parameters of the mechanism.

Determine the calculated value of the angle φ_{31}^{P} and compare it with the specified angle φ_{3_1} crank rotation:

$$\varphi_{3\_1}^{P} = \arccos\left(\frac{l_{AC_2}^2 + l_{AB_2}^2 - l_{B_2C_2}^2}{2 l_{AC_2} l_{AB_2}}\right) + \Delta\varphi. \tag{2}$$

If the difference $\Delta\varphi_{3\_1} = \varphi_{3\_1} - \varphi_{3\_1}^{P} = 0$, the obtained values of r and l, as well as predefined parameters of the mechanism, we take as final. If $\Delta\varphi_{3\_1} \neq 0$, you need to change the distance l_{AD}, the length l_{CD} of the rocker arm, which will change the initial angle γ_1 of the rocker arm installation and the angle φ_{31}^{P}.

The obtained dependences allow, as a result of metric synthesis of the mechanism of guide needles with variable links, to establish constant parameters of the kinematic scheme, which provide the law of motion of guide needles according to the cyclogram of the warp knitting machine.

Summary

Based on the analysis of the existing designs of variable structure mechanisms used in light industry machines, the structural schemes of the four-link variable structure mechanism for the drive of the guide needles of the WK-machine are proposed. The metric synthesis of the mechanism is offered.

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