STRUCTURAL ANALYSIS OF THE MECHANISM WITH A THIRD-CLASS STRUCTURE GROUP OF THE FOURTH ORDER

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Introduction. Improvement of existing technological equipment, design of new reliable and productive competitive light industry machines requires developers to perform structural and kinematic investigations of the mechanisms of such machines. The technological process requires the equipment to ensure the movement of working bodies according to predetermined trajectories and in accordance with the required laws, and the maximum productivity of such machines is possible at significant speeds of the main shaft. The condition for increasing the angular velocity requires a failure in the structure of mechanisms from structural groups of links with the presence of higher kinematic pairs. Therefore, instead of cam mechanisms in modern knitting machines trying to use hinged mechanisms loop-forming bodies with a large number of links and structural groups of higher classes. So, the simplest swing mechanism, which provides the stop of the loop forming body, depending on the rotation of the main shaft at an angle to ninety degrees, consists of six moving parts, and a longer stop can be obtained by means of a swing mechanism with even more movable links. In the context of the forego-
ing, structural studies of complex planar structural groups with six movable links and nine kinematic pairs are relevant.

**Analysis of basic research and publications.**
Complex flat mechanisms are not left out of research and publications of professional editions of recent years. In a number of papers, attention is paid to the problems of the synthesis of such mechanisms [1], in particular the mechanisms used in the equipment of light industry [2]. The questions of the structural study of complex planar mechanisms of the fourth class [3] are considered, kinematic and power investigations of higher class mechanisms [4] are carried out, for example, the kinematic investigations of the mechanisms of the third [5, 6] and sixth [7, 8] classes, in particular the mechanisms of light industry equipment [8].

**The aim of the study.** The purpose of the work is a structural study of the mechanism of the third order of the fourth order with the three leading cranks, based on the provisions on the property of mechanisms of higher classes to change their class, depending on the conditionally selected other possible initial mechanism, which enters into the structure of the administered structural groups of links of the mechanism being investigated. The problem is solved using the basic principles of the theory of the structure of the mechanisms of the course of the theory of mechanisms and machines.

**Presentation of the main material.** Consider the mechanism of platinum used in the basic machine, which is a complex third-class flat-hinged-lever mechanism (Fig. 1), consisting of leading links 1 – 3 that are connected to the riser 0 and other driven links 4 – 11, among which are links 4 – 8, 10 – rods, 9, 11 – rails.

Mechanisms of the first class (links 0, 1), (links 0, 2), (links 0, 3) together with the structural group of the third kind of the fourth order, which includes a set of six moving units 4 – 9 (n = 6), together with the nine kinematic pairs of the fifth form A1, A2, A3, B, C, D, E, F, O4 (p5 = 9) and the structural group of the second class (links 10, 11) form a third-class mechanism with a degree of freedom three and three leading cranks, the formula of which is shown in Fig. 2.

![Fig. 1. Kinematic scheme of the third class mechanism](image)

\[
\begin{align*}
&\text{1 class (links 0, 1)} \quad \text{3 class 4 order} \quad \text{2 class 2 order} \\
&\text{1 class (links 0, 2)} \quad \text{(links 4 – 9)} \quad \text{(links 10, 11)} \\
&\text{1 class (links 0, 3)}
\end{align*}
\]

*Fig. 2. Formula of structure*

Movements of cranks 1–3 are interconnected by means of an ordinary gear transmission. The crank 1 is driven by the main shaft of the machine, with the crank 2 having a double, and the crank 3 – a triple angular velocity compared with the angular velocity of the crank 1.

The movement of the platinum loop-forming mechanism is determined by a connecting rod 7, which in turn is driven by driving links rotating with angular velocities of varying magnitude and direction. The structural feature of the mechanism is the presence of closed circuits B, C, D, and E, F, C, formed by the kinematic pairs of the connecting rods 7, 8.

We consider movable links 2, 3 of the original mechanisms conditionally fixed. From the formula of the structure of the mechanism (Fig. 1) we have a formula, where the leading link is the crank 1 of one initial mechanism (Fig. 3):

\[
\begin{align*}
&\text{1 class (links 0, 1)} \quad \text{3 class 4 order} \quad \text{2 class 2 order} \\
&\text{(links 4 – 9)} \quad \text{(links 10, 11)}
\end{align*}
\]

*Fig. 3. Formula of structure*
We study the mechanism in the sequence, which is due to another conditionally possible leading link 3. If the initial mechanism to choose a set of links, 3, 6 – the formula of the structure of the mechanism has the form (Fig. 4):

\[ \text{1 class (links 3, 6)} \rightarrow \text{2 class 2 order (links 5, 8)} \rightarrow \text{2 class 2 order (links 7, 9)} \rightarrow \text{2 class 2 order (links 10, 11)} \rightarrow \text{2 class 2 order (links 1, 4)} \]

*Fig. 4. Formula of structure*

If the leading link is to arbitrarily select link 5, changes in the formula of the structure of the mechanism are observed in the structural group, which is directly attached to the original mechanism (Fig. 5):

\[ \text{1 class (links 2, 5)} \rightarrow \text{2 class 2 order (links 6, 8)} \rightarrow \text{2 class 2 order (links 7, 9)} \rightarrow \text{2 class 2 order (links 10, 11)} \rightarrow \text{2 class 2 order (links 1, 4)} \]

*Fig. 5. Formula of structure*

For both cases, conditionally, other leading links, the mechanism under investigation becomes the mechanism of the second class, that is, it becomes a mechanism to which structural groups of the second class arrive, for which the movements of the conditionally leading link 6 (Fig. 4) or 5 (Fig. 5) are uncertain, and the managed link 1 – is given.

The influence of the movement of the link 2 on the parameters of other driven parts of the mechanism is established for cases when the links 1, 3 are considered to be conditionally stationary. The formula of the structure of the mechanism takes the form of the formula shown in Fig. 3 provided that the leading link is a crank 2. For cases of other conditionally possible initial mechanisms, the formula of structures is presented in Fig. 6 and Fig. 7:

\[ \text{1 class (links 1, 4)} \rightarrow \text{2 class 2 order (links 7, 9)} \rightarrow \text{2 class 2 order (links 10, 11)} \rightarrow \text{2 class 2 order (links 2, 5)} \]

*Fig. 6. Formula of structure*

\[ \text{1 class (links 3, 6)} \rightarrow \text{3 class 4 order (links 2, 4, 5, 7, 8, 9)} \rightarrow \text{2 class 2 order (links 10, 11)} \]

*Fig. 7. Formula of structure*

Formulas of the structures of the mechanism, which allow find out the effect of crank movement 3 for two possible variants of other conditional driving links, have the form of formulas shown in Fig. 8 and Fig. 9:

\[ \text{1 class (links 3, 6)} \rightarrow \text{2 class 2 order (links 5, 8)} \rightarrow \text{2 class 2 order (links 7, 9)} \rightarrow \text{2 class 2 order (links 10, 11)} \]

*Fig. 8. Formula of structure*

\[ \text{1 class (links 3, 6)} \rightarrow \text{3 class 4 order (links 2, 4, 5, 7, 8, 9)} \rightarrow \text{2 class 2 order (links 10, 11)} \]

*Fig. 9. Formula of structure*
Conclusions The structural investigation of the mechanism of the third order of the fourth order with the three leading cranks is executed, which is based on the provisions about the property of the mechanisms of higher classes to change their class, depending on the conditionally chosen other possible initial mechanism. The formulas of the mechanisms of the mechanism are obtained, which allow simplify the research and determine the sequence of further kinematic analysis of such a mechanism and obtain results with greater accuracy of calculations.

Literature


References


