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

С.О. Кошель, Г.В. Кошель. **Структурний аналіз механізму з структурною групою третього класу четвертого порядку**. В технологічному обладнанні легкої промисловості завжди використовувалися та будуть застосовуватися складні багатоланкові плоскі механізми вищих класів. Пов'язано таке зі складністю траєкторій та законів руху робочих петлеутворюючих органів технологічного обладнання цієї галузі виробництва, що було би неможливим без механізмів, до складу яких не надходили би плоскі структурні групи ланок вищих за другий клас за загальновідомою теорією будови механізмів за Ассуром. Новітні технології, що використовуються в виробництвах вимагають від виробників обладнання застосування в машинах механізмів зі структурними групами ланок третього, четвертого та вище класів. Методи дослідження структурних груп, до яких надходять чотири ланки та шість кінематичних пар, що утворюють структурні одиниці третього класу третього порядку або четвертого класу другого порядку, на основі яких синтезуються механізми, відповідно, третього або четвертого класів сьогодні є досить відомими. Інша ситуація спостерігається з структурними групами, утвореними шістьма ланками та дев'ятьма кінематичними парами - вони використовуються або мають певні перспективи застосування в машинах технологічного обладнання легкої промисловості при умові їх недостатнього аналізу, що пов'язано з відсутністю загальноприйнятих методів дослідження таких груп в зв'язку зі складністю їх проведення. Метою роботи є проведення структурного аналізу механізму з структурною групою ланок третього класу четвертого порядку за допомогою способу, в якому умовно змінюється початковий механізм, що призводить до визначення такої послідовності дослідження, для якої спостерігається зменшення класу механізму з одночасним спрощенням його подальшого аналізу. При проведенні даного дослідження враховується структурна особливість механізму, а саме - наявність трьох ведучих ланок механізму.
Ключові слова: механізм, структурне дослідження, клас механізму, структурна група ланок

S. Koshel, G. Koshel. **Structural analysis of the mechanism with a third-class structure group of the fourth order.** The technological equipment of light industry has always used and will use complex multi-tier flat mechanisms of the upper classes. It is connected with the complexity of the trajectories and laws of motion of the workers of the loop-forming organs of technological equipment. This would not have been possible without the flat structural groups of links exceeding the second class in the well-known theory of the structure of mechanisms according to Assur. The use of the latest technologies in production require from manufacturers of technological equipment such machines that use mechanisms with structural groups of links of the third, fourth and higher classes. Research methods of structural groups that are formed by four links and six kinematic pairs, forming structural units of the third class of the third order or the fourth class of the second order are quite well known today. A different situation is observed with structural groups formed by six links and nine kinematic pairs. Such structural groups of links are used subject to insufficient analysis. There are no generally accepted methods for studying such groups of links due to the complexity of their implementation. The aim of the work is to conduct a structural analysis of the mechanism with a structural group of links of the third class of the fourth order using the method in which the initial mechanism conditionally changes. This leads to the determination of such a sequence of research, for which a decrease in the class of the mechanism is observed with a simultaneous simplification of its further analysis. When conducting this study takes into account the presence of three leading links of the mechanism.
Keywords: mechanism, structural study, mechanism class, structural group of links

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-

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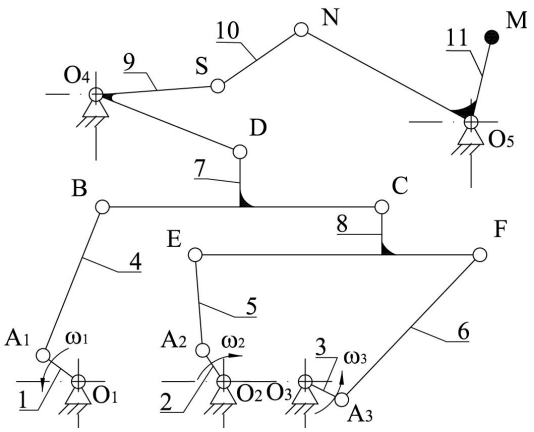

Fig. 1. Kinematic scheme of the third class mechanism

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 A_1, A_2, A_3, B, C, D, E, F, O_4, (p_5 = 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.

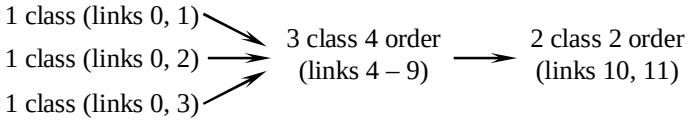

Fig. 2. Formula of structure

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):

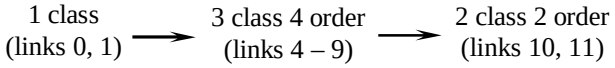

Fig. 3. Formula of structure

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):

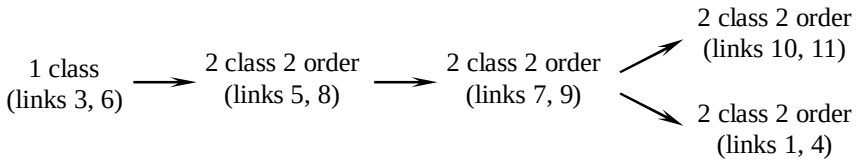

Fig. 4. Formula of structure

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):

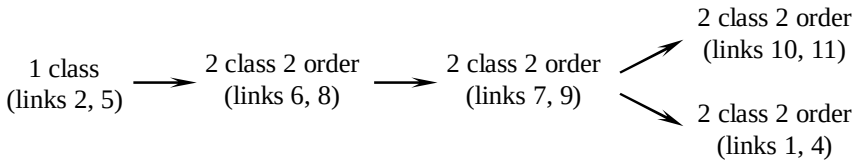

Fig. 5. Formula of structure

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:

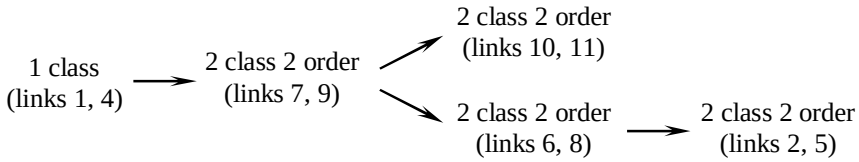

Fig. 6. Formula of structure

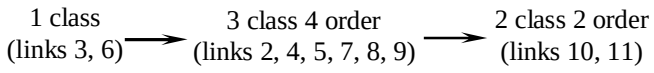

Fig. 7. Formula of structure

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:

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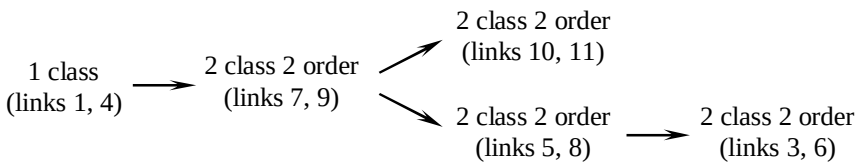

Fig. 8. Formula of structure

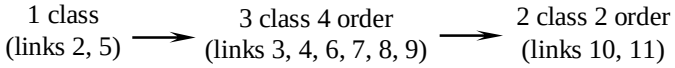

Fig. 9. Formula of structure

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.

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