ABSTRACT OF THE DOCTORAL THESIS

"CONTRIBUTIONS TO THE ANALYSIS AND SYNTHESIS OF CAM MECHANISMS"

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THE FIRST PART:

LITERATURE DATA CONCERNING THE CAM MECHANISMS

1. INTRODUCTION

Different classifications of cam mechanisms, plane and spatial, according to constructive criteria, as well as according to their kinematic possibilities, are presented. Numerous kinematic lay-outs of cam mechanisms are given, such as those in Fig. 1.

2. CONSTRUCTIVE SOLUTIONS USED WITH CAM MECHANISMS

Numerous assembly and subassembly sketches of cam mechanisms are given, as well as constructive solutions for various kinematic lay-outs. We also present certain versions of mechanisms with adjustable cams, which allow the obtaining of different movement laws, depending on the adjustment made.

3. METHODS OF KINEMATIC ANALYSIS OF THE CAM MECHANISMS

There are numerous graphic and grapho-analytical methods used in the past for the kinematic analysis of cam mechanisms; in this thesis, we have presented principally these methods which involve the building of various polygons for every position of the mechanism. The very diverse analytical methods are also presented; they are based on the trajectory of the contact point between the contour of the cam and the tappet and also on many considerations from the Analytic and Differential Geometry.

4. THE DYNAMIC OF THE CAM MECHANISMS

The dynamic of the cam mechanisms has been and still is widely studied. The used methods vary according to the chosen dynamic models. The studies reach the final differential equations, which are difficult to solve, because of the fact that numeric methods are applied, needing data from real mechanisms. Many examples are given concerning dynamic methods, mathematic and numerical solutions, and stands made for this purpose.

5. THE SYNTHESIS OF THE CAM MECHANISMS

There are many grapho-analytical methods through which the synthesis of cam mechanisms has been made throughout the time. These methods are presented in this thesis. Methods have also been elaborated and are presented here, concerning the analytical synthesis of cam mechanisms, but with specific applications, without the existence of a general, complete method. Many relations based on Differential Geometry are given, necessary for studying the contour of the cam, in the synthesis.

6. THE OPTIMIZATION OF THE CAM MECHANISMS

Various research concerning the optimization of the cam mechanisms is presented. Usually, only actual cases are given, without establishing general methods. The objectively frequent functions are generally built on the criteria of the limitation of certain parameters of the mechanism: speed, acceleration, pressure angle. Usually, the optimization restrictions are: the size of the mechanism, the critical pressure angle, the exploitation shocks. We have also presented mathematical and numerical methods used for the optimization of the cam mechanisms.

7. THE DESIGNING OF CAMS WITH LABELLED PROGRAMS

In recent years, specialized programs have appeared for the designing of various assemblies, subassemblies, machine parts, mechanisms. These programs, grouped into packs, with many modules, allow a very detailed design, with complete sketches and the necessary calculations. Some of these programs have the modules for designing the cam mechanisms. Many such examples, from literature, are given. With these programs, which cannot be modified, only the calculations provided by the creators can be made, according to the methodology established by them; other types of calculations, that the researcher might want, cannot be made.

THE SECOND PART

PERSONAL RESEARCH CONCERNING THE CAM MECHANISMS

8. ORIGINAL NUMERIC METHOD FOR DETERMINING THE RADIUS OF CURVATURE OF THE CAMS

The successive radii of curvature and the positions of the centres of curvature have been calculated using two methods: the classic, mathematic method, and an original numeric method. The idea consists in taking successive points on the contour of the cam and for three neighbouring points we can determine the radius of the circle approximating that curvature area, as well as the coordinates of the centre of curvature. The points will be taken successively: the first three points, then a point is discarded and the next one is added and so on. The curvature, representing the profile of the cam, is divided into a

large number of points and the radius of curvature is determined, as well as the centre of the arc of the circle approximating the closest the curvature arc in that area. The obtained results confirm the precision of the elaborated method. The numeric method is more advantageous in the case of the cams with complicated profiles, for which the equation of the contour is difficult to write and thus difficult to solve through the classic mathematic methods. Relations, tables, diagrams are given.

9. RESEARCH CONCERNING THE PRESSURE ANGLE OF A DISC CAM MECHANISM

The starting point is a disc cam with tappet with a translation movement (fig. 2), and the following relations are written:

The profile of the area in the contour of the cam is approximated by a polynom, then the α pressure angle is calculated. The results are given as tables and diagrams. Through numeric calculations, it has been determined that, by reducing the eccentricity, the pressure angle is also reduced. A new method for verifying the mathematic calculations was established, by using the method of the speed plan, transposed analytically.

10. RESEARCH CONCERNING THE ANALYSIS AND THE SYNTHESIS OF A FLAT TRANSLATION CAM MECHANISM

We have studied a mechanism with a flat translation cam on which a tappet equipped with two rolls leans. This mechanism has brought difficult problems in regards to structure, kinematics and synthesis. Structurally, the replacement mechanism has three dyads. The analysis of the mechanism has lead to a complicated movement law; several tables and diagrams are given. The synthesis of the mechanism is difficult because a non-linear algebraic system with 11 equations and 11 unknowns is reached. A problem of non-linear programming, with restrictions, is also reached. A simpler cam mechanism, conveying the same movement law, has been designed, thus establishing the profile of the cam.

11. THEORETICAL AND EXPERIMENTAL RESEARCH CONCERNING A CAM MECHANISM IN AN AUTOMATIC LATHE

We present an analytical calculation method for the mechanisms with cams and adjustable levers in the automatic lathes, processing pieces of bars (fig. 3).

The studied mechanism is rather complicated structurally, having three dyads. On the basis of the established algorithm, we have determined the influence of the adjustment of the length of a lever on the course and the advance. The algorithm and the established program have been proven through experiments. Fig. 4 represents the diagram of the

course of the knife in relation to the rotation angle of the cam. This calculation method can help establish, from the projecting phase, the area of use of every cam, thus avoiding the construction of many cams.

12. RESEARCH CONCERNING THE SYNTHESIS OF THE CAMS FOR THE TRANSVERSAL CARRIAGE OF AN AUTOMATIC LATHE

We present the method for establishing the course and the advance for any piece operated by a disc cam in transversal carriages. Several standard cams have been established, which can be used in processing most of the pieces, thus reducing the number of cams necessary for every piece that must be made. The created program can trace the theoretical profile of every cam, as well as the real profile, as envelope for the successive positions of the rolls. Relations, tables, diagrams are given.

13. THEORETICAL AND EXPERIMENTAL RESEARCH CONCERNING A MECHANISM WITH A CAM WITH TAPPET IN FLAT MOVEMENT

We have studied the kinematics of the mechanism in fig. 5, where the tappet has a flat movement. The contour of the cam offers an interesting law of the movement of the final lead element, that is the angle of the rocker as related to the rotation angle of the cam (fig. 6). A new calculation method has been used, which didn't involve the use of the principle of the inversion of movement. With the obtained results concerning the movement of the tappet, a simpler cam mechanism has been conceived, having the same law movement but a more complicated technology of the cam.

14. THE THEORETICAL AND EXPERIMENTAL STUDY OF A TWO-CAM MECHANISM PROVIDING THE MOVEMENT OF THE TABLE IN A MACHINE TOOL

We have started from the kinematic sketch of a two-cam mechanism (fig. 7) providing the movement of the table in a machine tool, in such a way that every point of it describes a parallelogram. Structurally, the mechanism is rather complicated, containing also a triad with interior translation thimbles. The method of kinematic analysis has been established, obtaining tables and diagrams which have been verified on a replica.

15. RESEARCH CONCERNING AN ORIGINAL CAM MECHANISM WHICH TRACES A CURVATURE IN SPACE

An original mechanism has been designed, with three cams forming a single part, generating complicated curvatures in space. Principally, the mechanism is given in fig. 8. The profiles 1 and 2 generate a flat movement of the point E belonging to the element 5. Profile 6 ensures the movement of the element GEM, with the tracking point M, through the guideway of E. Structurally, the mechanism is very complicated, being of the spatial

type. It has 5 independent contours, of the 3 and 4 families. The apparent family has been used for determining the degree of mobility. The kinematic of the mechanism has been studied, for two types of movement laws generated by the cams. The profiles of the cams have been drawn, and complicated special curvatures have been generated. The elaborated programs have a general character. We have presented views of the cam with three profiles, using advanced labelled programs. Fig. 9 depicts two profiles of the singular cam and fig. 10 depicts the third profile.

The doctoral thesis has 264 pages.

The bibliography comprises 163 bibliographic references.

SUMMARY