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SYSTEMIC APROACH OF THE CONSTRUCTIVE-FUNCTIONAL CHARACTERISTIC OF THE DENTICULATE BY KNIFE-WHEEL MACHINE TECHNOLOGICAL SYSTEM

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Abstract: *The gear shaper machines are meant for the execution of the external and internal with straight and leaned teeth cylindrical toothing. The work principle of these machines is based on simulating the engagement of two gear-wheels from which one is the wheel-semi manufactured article and the other one is the generating wheel described by the movement of the knife-wheel. The construction of the gear shaper is determined by two characteristics: the position of the axes wheel-semi manufactured article and of the tool; by the assembly of the machine that makes the removable movement between the tool and the piece during the tool withdraw from preparing. No matter what their constructive variants are, these machines have the same constructive-functional. These characteristics are systemic presented in the paper. Therefore, the gear shaper machines are being analysed under the representation of technological system.*
Keywords: *gear shaper, technological system denticulate machine**,** working accuracy.*

1. INTRODUCTION

According to its' definition and also to its' specifications, it is considered that the denticulate by wheel-knife machine may be systemically approached under the representation of denticulate by wheel-cutting machine technological system ST^{md}. On the basis of the analytical expression of the technical system, it is considered that the technological ST^{md} may be defined by means of the next formalized descriptor [1]:

$$ST^{md} = \{ \{C_{p,j}\}, \{R_{int}(C_{p,j})\}, \{R_{ext,m}\}, \{S_c^{STmd}\}\}; \qquad (1)$$

In which:

$\{C_{p,j} \mid j = (1 \div k)\}$ represents the finite amount of the forming components of the technological system ST^{md}.

$\{R_{int}(C_{p,j})\}$ - represents the finite amount of the internal relations that established among the elements $C_{p,j}$. The number of the internal relations is determined by the number of the combinations k_{int} that may be created among the components $C_{p,j}$ and the their punctual characteristics. The number of the combinations k_{int} is determined by the number k_{Cpj} of C_{pj} components and the number k_n ($k_n < k$) of components among which these relations are established. These may be determined by the fallowing formula:

$$k_{int} = \frac{k_{C_{pj}}!}{k_n!(k_{C_{pj}} - k_n)!}; \qquad (2)$$

$\{R_{ext,m} \mid m = (1 \div w)\}$ - the finite amount of the external relations that the technical system ST^{md} establishes with different components of the environment M_e^{md}. This way can be mentioned the components that define the capability clues of the wheel-knife denticulate machine, the components that define the denticulate by wheel-knife technological system, etc;

$\{S_c^{STmd}\}$ - the finite amount of purposes that the technological system ST^{md} must accomplish.

2. TECHNICAL REQUIREMENTS

From a constructive point of view, the technological system ST^{md} may be described through the next particularities:

- it may be schemed [1], [2] as a variable open frame (Fig1). At its' ends the tool and the wheel of the denticulating piece are situated. To the frame a still reference system may be attached: the system OXYZ, or two mobile reference systems: 1. the system $O_m X_m Y_m Z_m$ that is interlocked with the table of the tool-machine and with the wheel-denticulating tool put on the machine's table: 2. the system $O_sX_sY_sZ_s$ that is interlocked with knife holder drop and with the cutting tool, put on the holder knife drop;
- it is formed of the next main subsystems: the lifting power subsystem S_p^{md}; the kinematics structure subsystem S_c^{md}; the auxiliary subsystem S_a^{md}; the electric and hydro drive subsystem S_{eh}^{md}; the command subsystem S_{cd}^{md} [3].

Under this structure, the system ST^{md} may be analytically expressed through the expression:

$$ST^{md} = S_p^{md} \cup S_c^{md} \cup S_a^{md} \cup S_{eh}^{md} \cup S_{cd}^{md}, \quad (3)$$

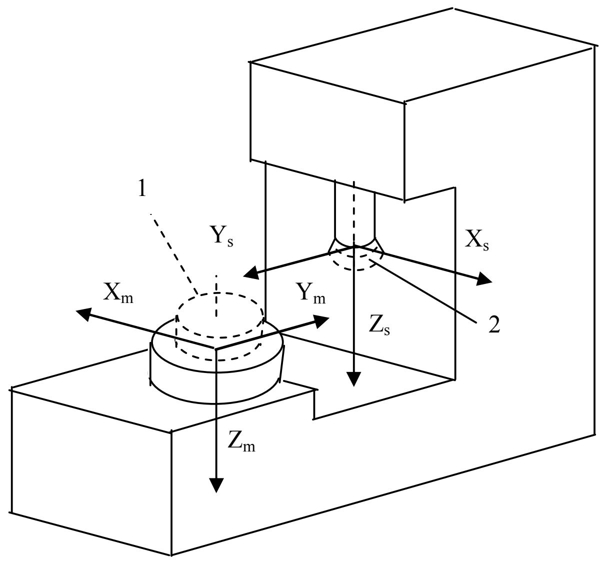

Figure 1 The representation of the technological system denticulate by knife-wheel machine ST^{md} : 1 – wheel-piece; 2 – knife-wheel; $O_mX_mY_m Z_m$ –the reference system attached to tool-machine's table; $O_sX_sY_sZ_s$-the reference system attached to the lifting-knife drop.

The lifting subsystem has as its' main function the polygon's cutting forces enclosure and the insurance of the fixed reciprocal position between the semi article and the wheel - semi manufactured article during the cutting process. This system contains two main subsystems: the knife holder drop subsystem; elements of structure subsystem. The knife holder subsystem is principially shown in figure 2. This is characteristic for the technological system ST^{md}. The construction of the knife holder drop subsystem is, with some unsignificant small differences, similar to any kind of construction of the ST^{md}. It is principially composed from: knife holder drop subsystem (1); knife-wheel subsystem (2); the mechanism for upholding the knife holder drop in the superior position subsystem (3);the axis drop-equipped subsystem (4); the guidance-axis knife holder drop subsystem(5); the superior wormed rim subsystem (6); the spatial cams subsystem (7).

The elements of structure system are schematically presented in figure 3. It is principially composed from: the frame work subsystem (1), the frame work guidance subsystem (2); the rotative table subsystem (3); wheel - semi manufactured article subsystem (4); the guidance—rotative table subsystem (5); the sledge-table subsystem (6); the inferior worm of the machine's table subsystem (7).

From a functional point of view, the technological system ST^{md} is characterized by its' real working precision $P_{L,R}$, the technological precision P_T , etc.

Related to the real working precision it may be distinguished the fallowing:

- its' value dimensioning mechanism is described by relations that derive from applying the method of the technical system's state evolution [1];
- the real working deviation, of the ST^{md} corresponding to the real working precision is dimensioned by means of the relations that derive from the quality production process of the technological system ST^{md};
- the real working precision is influenced by the constructive-functional particularities of the technological system ST^{md} structure.

The accuracy of the tool-machine is „dimensioned" during the entire machine's life time: projection, fabrication, exploitation. Thus, are named the geometrical accuracy, the cinematic accuracy, the rigidity of the tool-machine and the dynamic accuracy. The study of the dynamic accuracy must take into consideration the fact that the mechanic system corresponding to the gear shaper machine is of the variliniar type. Because the gear shaper machines have a closed cinematic chain, the four types of accuracy simultaneously determine the work accuracy of the machine.

An important component of the work accuracy is represented by the rigidity of the tool-machine. There are known the next categories of rigidity : [4], [5] static rigidity; cvasistatice or technological rigidity; dynamic rigidity.

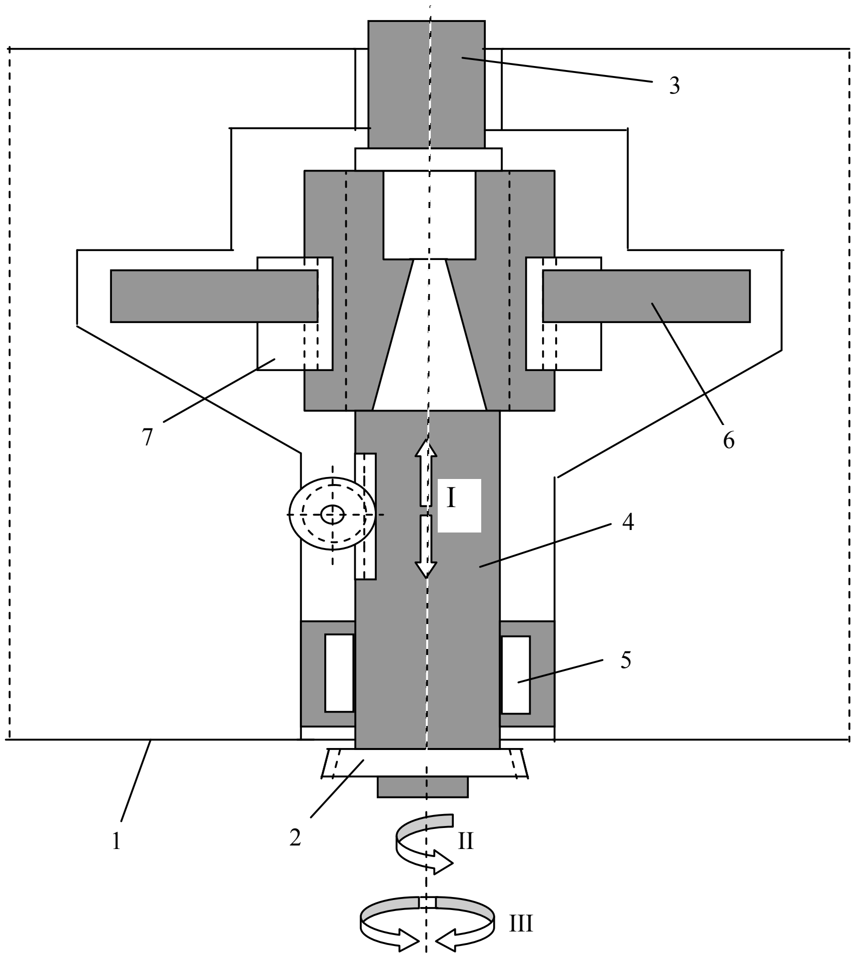

Figure 2 The principially representation of the subsystem knife holder drop : I- the cutting main movement; II- the rolling-dividing movement; III- the oscillatory rotation movement.

Among these three categories functional correspondents are established. In the case of the gear shaper machinne, the static rigidity $K_{s,\,md}$, that is determined by the action of the total cutting force $F_{aş}$ is expressed by the relation [1]:

$$k_{s_{md}} = \sqrt[a]{\frac{v_{aş} \cdot T^{m} \cdot h^{d} \cdot s_{c}^{x_v}}{C_{k_s} \cdot k_v}} \tag{3}$$

in which [1], [4] : v_{as} represents the main cutting velocity; T – the tool's durability ; h – the toothing's depth ; s_c the circular advance ; m, d, x_v, C_{ks}, K_v – correction coefficients.

It is noticed that the parameters of the cutting regime (v_{as}, s_c and T) and the constructive characteristics of the prepared wheel directly influence the static rigidity $K_{s,\,md}$.

The static behaviour δ of the denticulate by knife-wheel technological system, under the cutting force $F_{aş}$ is described by means of the relation:

$$\delta = \begin{Vmatrix} \delta_x \\ \delta_y \\ \delta_z \end{Vmatrix} = \begin{Vmatrix} C_{s_{xx}} & C_{s_{yx}} & C_{s_{zx}} \\ C_{s_{xy}} & C_{s_{yy}} & C_{s_{zy}} \\ C_{s_{xz}} & C_{s_{yz}} & C_{s_{zz}} \end{Vmatrix} \cdot \begin{Vmatrix} F_x \\ F_y \\ F_z \end{Vmatrix} \tag{4}$$

in which: δ represents the tool's and the semi manufactured article's removal, in space, of the fixed related position, at the beginning of the preparing, reported to the system OXYZ; δ_x, δ_y and δ_z are the removal projections of the δ; $C_{s,xx}$, $C_{s,yy}$, $C_{s,zz}$ – direct, static, linear yielding; $C_{s,xy}$ $C_{s,xz}$….etc. - transversal, linear static yielding; F_x, F_y si F_z – the cutting force components $F_{aş}$.

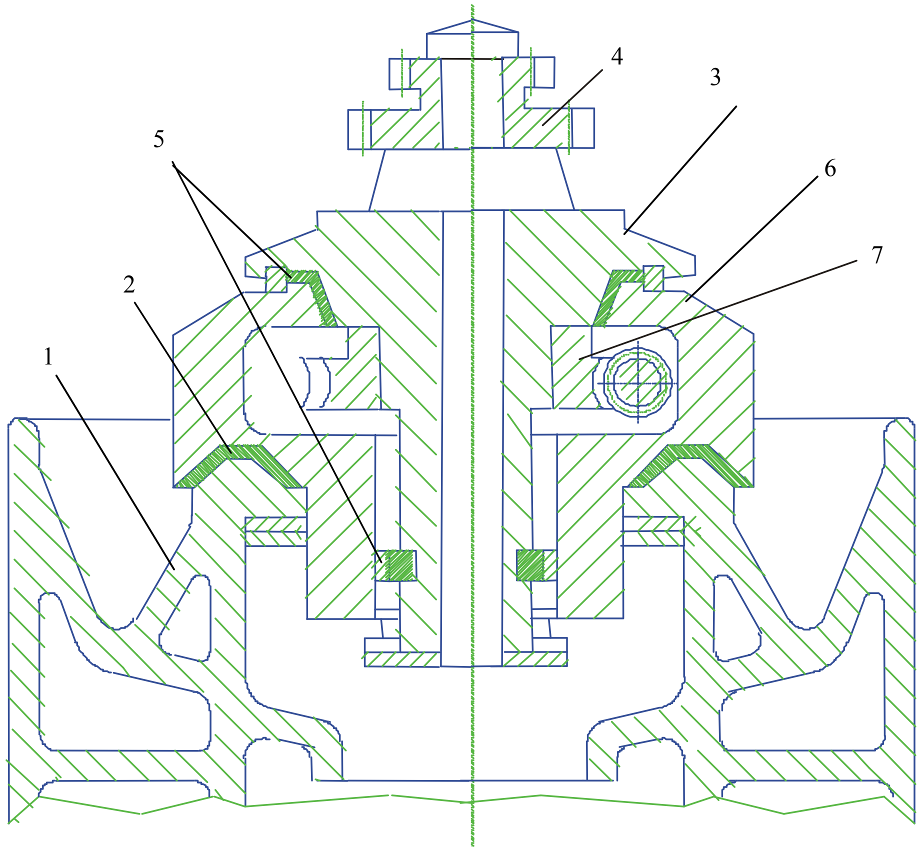

Figure 3 The fundamental in facts constructive representation of the elements of structure system

3. CONCLUSION

The systemic approach of the denticulate by knife-wheel machines defines the concept of denticulate by knife-wheel machine technological system. By means of there are distinguished the main subsystems that define the construction of the tool-machine: the lifting power subsystem S_p^{md}; the kinematics structure subsystem S_c^{md}; the auxiliary subsystem S_a^{md}; the electric and hydro drive subsystem S_{eh}^{md}; the command subsystem S_{cd}^{md}. Also, the functional characteristics of the denticulate by knife-wheel machine technological systems are identified. Within these characteristics the rigidity plays an important role. The relation that defines the static rigidity shows the link between the parameters of the cutting regime and the constructive rigidity measure of the prepared tool-machine.

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