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SOME CONTRIBUTION UPON THE REVOLUTION EXTERNAL SURFACES ROTOROLLING

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ABSTRACT

The paper presents some aspects concerning the exterior revolution surfaces rolling and rotorolling, starting from the actual known study about this field researches. It is presented a kinematic schema of a working head tools realized by the authors, device that allows the practical application of this technological process. The kinematic schema of the realized and used head for rotorolling through SCPD for the metallically surfaces put in evidence his component elements and also the necessary working movements, in view to apply the process.

KEYWORDS: superficial cold plastic deformation, rotorolling, hardening

1. INTRODUCTION

The hardening through superficial cold plastic deformation (SCPD) or, the metallically matrix hardening can produce, according to (Wanyorek, 1980; Wisniewski, 1985), the similarly final effects to the drawled process through:

- termical operations (in the entaier mass of the metallically body);
- termochemical operations (beside the structure modification obtaining chemical modifications in the superficial layers);
- termomechanical operations (the physical and mechanical properties modifications being accentuated also by the material hot plastic deformations, in the austeniticaly process, at metallically high temperatures);
- cover and loading operations with tough alloy surfaces (the added material physical and mechanical properties being superior to those produced through other processes, over the metallic base)

The fact that the materials superficial cold plastic deformation (SCPD) leads to physical and mechanical structure properties modifications, concomitantly with modifications of the surfaces geometry conditions (roughness R_a),after [Lupescu, 1999]. Also he can be defined as a superficial mechanical treatment process of these and can be placed together with other processes, with similarly action, previous presented.

The fact that, in the engineering construction the pieces with exterior revolution cylindrical surfaces represent a weight of 60 – 70 % [Duşa 1993], more then, these have imposed mostly qualitative restriction conditions (R_a) and superficial hardness layer (HV), depending by their exploitation conditions, it is completely justified the SCPD process application through rolling or rotorolling.

One follow in this way, beside the performance indicators reached the replacement of the cutting detach methods (expensive, less productive, with high consumption of cutting tools) with processes without cutting detach, type upper remembered. Between them, the rotorolling process can be applied generally for cylindrical pieces with a simple geometry, preferring without steps or disengagements: axis, bolts, dowels and so one.

2. METHOD USED

Principally the solution proposed by the authors concern in a rolling application, to rigid heavy shafts (1/d > 10 and Φ=100÷500 mm and over), on their cylindrical surfaces (drawing roller plane on). This was realized under the rigid device contact form, unbalanced, with hydraulic action (figure 1).

The working head, that effectuate the rotorolling, together with the other component elements of the device, acted by the electro engine 63 prints to him a planetary motion. The vertical displacement of all this

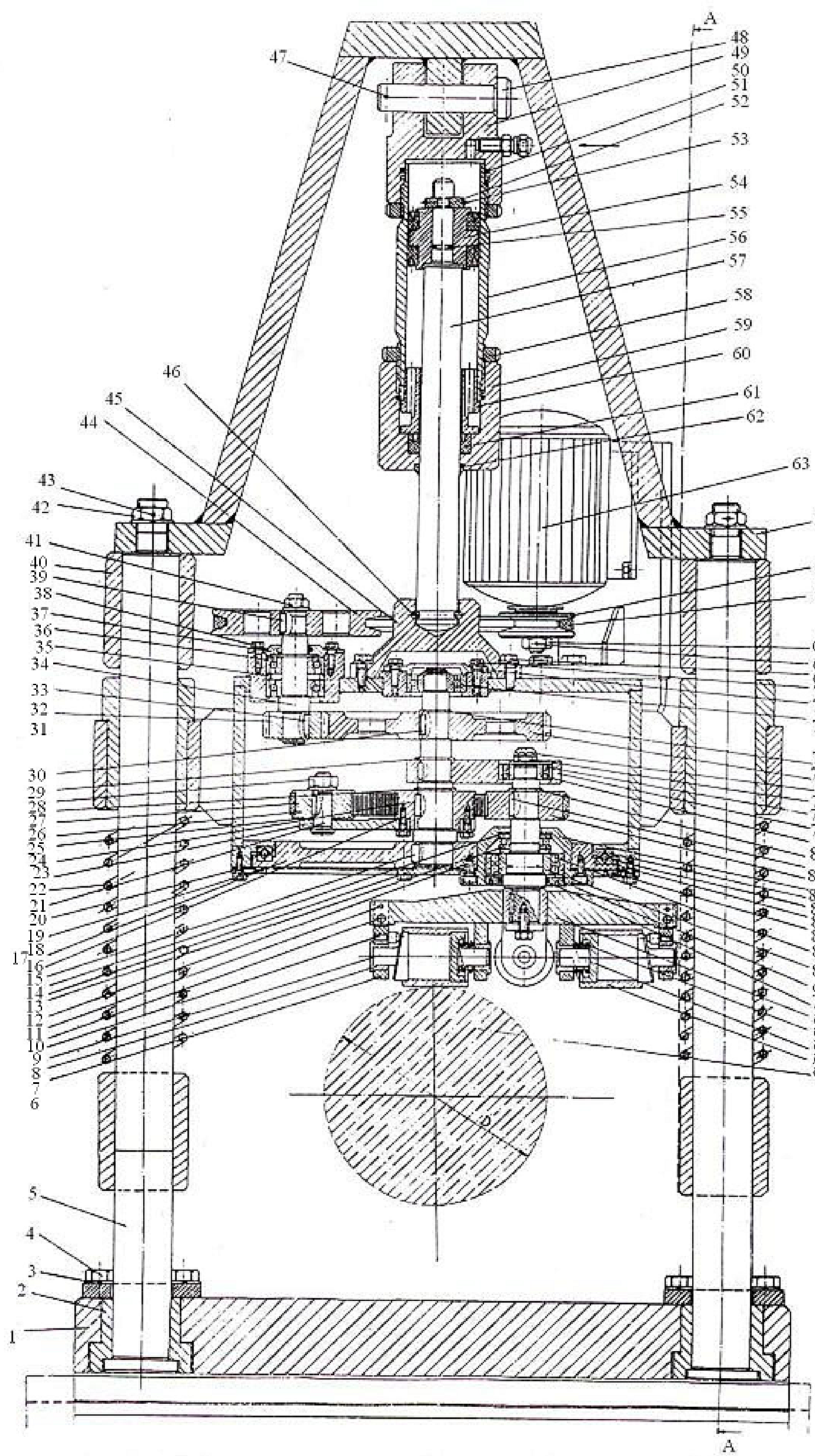

Fig.1 The assembling schema for the rotorolling equipment

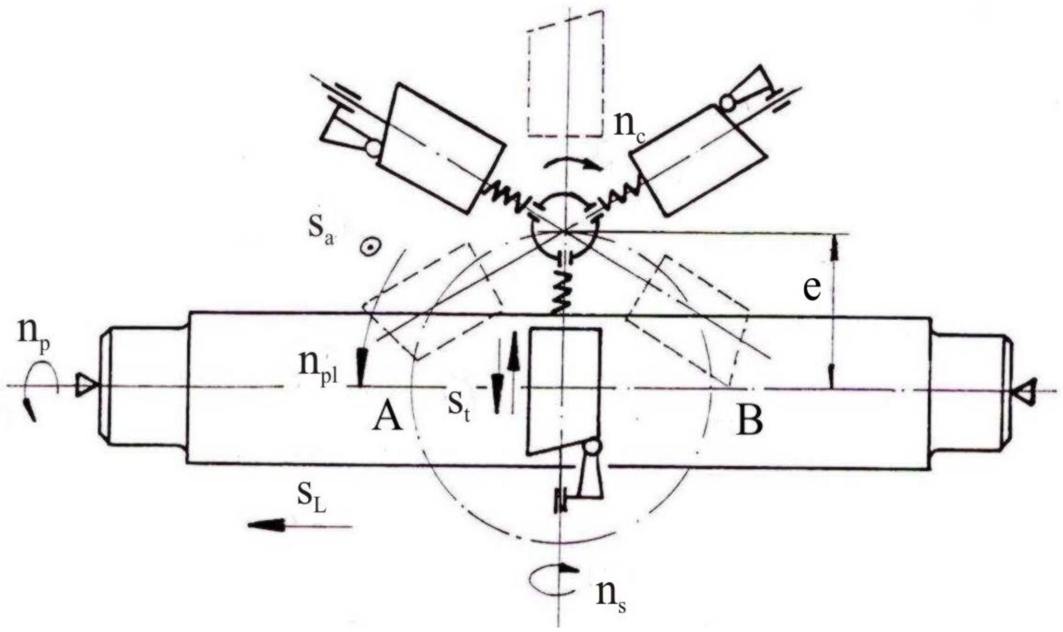

Figure 2 Fundamental schemes for the rotorolling head

elements is done using the columns 5, through some jig bushing. This vertical movement is printed by the rod 57 of the hydraulically engine piston 51 and serve both to the approach working head to the processed surface, as well as, to the desired rotorolling force pressure realization.

Taking over the shocks at the entrance in contact of the working heads rolls with cylindrical processed piece is done through the elastically elements existing on the two columns of the device.

The entire assembly will be mounted on a SN 560 lathe cart and when the longitudinal advance is coupled, the device gets over the entire processed pieces generators. Beside the originally elements of the entire device constructive solution, originally is also the working head construction designed for the execution complexity necessary to the rotorolling process application.

In this direction it was started from the Saturov idea [Saturov 79] unmaterialized, to use as a rolling tool, of a long cylindrical roll that execute a rotating motion around of his axis, another one, towards for a normal axis of this in the instantaneous roll- pieces contact point, as well as, a rotation motion with a eccentricity„e” according to his solidarity position, in the catching device of these.

The new author’s solution proposed consists in SCPD technological equipment through rotorolling, whose constructed principle can be followed in a kinematic schema from figure 2. One can see in this figure that the working head tools is endowment with 3 cylindrical rolls, frontal cam type, star connected, which execute a rolling n_c motion towards to the head principal axis.

The all used rolls also recive:

- a n_c rotation motion around their axis due to the friction contact with the working piece, whose speed is n_p;
- a s_t low amplitude alternating rectilinium motion, due to the pusher contact with the frontal roll surface, at his rotation motion and also through the compression or the relaxion of some elastic elements;
- a n_{p1} of the entire star rolls rotating movement, all around the central device axis. The entire assembling realise also a s_a displacement to the piece, to obtain the rotorolling pressure force, together with the longitudinal head feed s_l the piece axis direction. The planetary motion determine also a second rollers pass when the B point arrives in the initial position A but, not necessity, on the same elementary piece surface unit. This depends by the rolling head longitudinal feed size and also, from the worked piece speed.

3. RESULTS

A first evolution of the microgeometry of the processed exterior cylindrical surfaces through rotorolling with the help of the device previously presented, is given by the profilogram surfaces obtained, compared with the profile realized at the previous processing (rough turning) of the OL37 steel (fig 3 a and b), realized with the profilometer SURTRONIC 3P. Indifferently to the rotorolling processed material nature, one obtains a significant subsidence of the microasperity: decreasing about 10 – 19 times - when one works in optimum conditions (minimum values of the advances and of the speed pieces in rotorolling process, at high loading forces generated through the vertical displacement of the working head with rolls

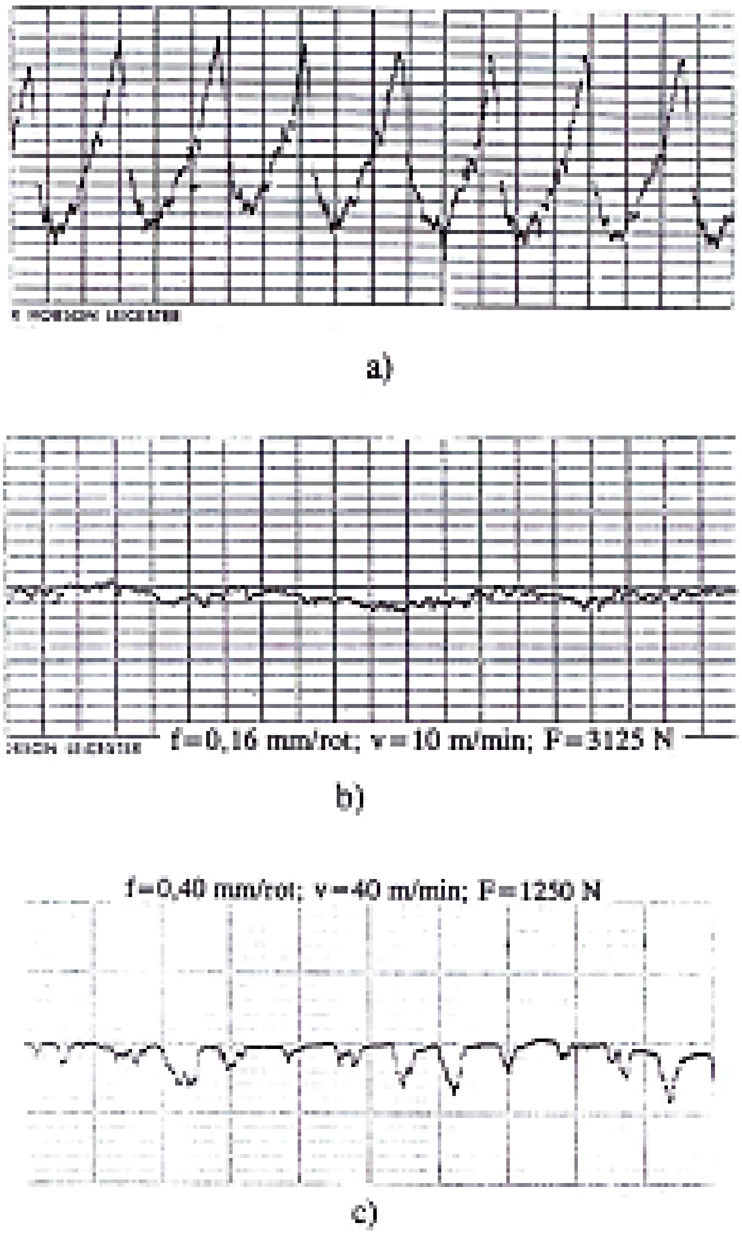

Fig. 3 The study of profilografic at tests from steel OL37
a. R_a = 6,281 μm (turning rough); b. $R_{a\,min}$ = 0,573 μm (after rotorolling);
c. $R_{a\,max}$ = 1,895 μm (after rotorolling);

in star) fig 3b or, respectively about 3 - 4 times – when it is working in unfavorable conditions (small loading, big advances and speeds used at rotorolling fig 3c).

A quantitative estimation of the manner in which the used working regime parameters variation at rotorolling influence the polishing degree of the processed cylindrical surfaces through this superficial mechanical treatment is given in table 1.

Here one can see the roughness values obtained at hardening, and there 2D and 3D representations being in figure 4.

Analyzing the values from the table, one can remark the rotorolled surfaces roughness decrease, on the values force increasing measure. This is a naturally thing in the superficial plastic deformation processes cases but also, one can see a phenomenon of a easy aggravation of the polishing degree– at loadings that exceed 3500 – 3700 N.

The 3D graphic representation from fig. 5, as a surfaces answer to the combined variance action for each two regime rolling parameter, dignify more obvious the degree in which each of them contributes to the microrelief surfaces generation.

Table 1The roughness values average obtained at the hardness through rotorolling

Material	Rolling speed V, [m/min]	Advances at rolling V, [m/min]	Push forces F, [N]				
			1250	1870	2500	3125	3750
OL37	10	0.10	0,903	0,780	0,758	0,575	0,653
		0.16	0,885	0,738	0,663	0,573	0,621
		0,20	0,896	0,830	0,738	0,641	0,660
		0,315	1,048	1,028	0,773	0,680	0,766
		0,40	1,601	1,273	1,095	0.911	1,045

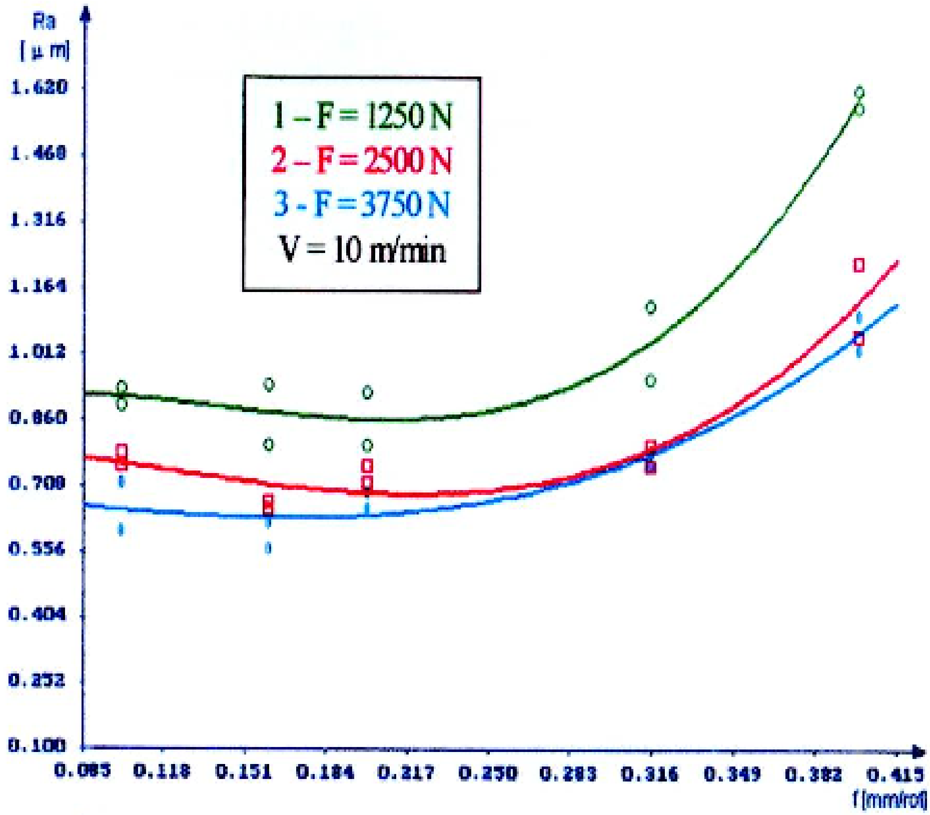

Fig.4. The work advances influence about the roughness at rotorolling of the steel OL37, at different push forces

S min 1 = 0.000027; S min 2 = 0.004374; S min 3 = 0.003003;

$Ra = a_0+a_1f+a_2f^2+a_3f^3$

The values of the coefficients are:

1. a_0=0,82756; a_1=2,53036; a_2= -22,35837; a_3=52,14636
2. a_0=0,79247; a_1= 0,33786; a_2=-10,00513; a_3= 28,20084
3. a_0=0,70231; a_1= -0,50774; a_2= -1,87177; a_3= 13,39828;

4. CONCLUSIONS

The rotorolling application as a SCPD proceeding and the practical usage of the realized device, leaded at the following conclusions:

- the microasperity “subsidence” can be explained through mechanical deformation (elasto – plastic) suffered by the surfaces contact junction microasperity, at specifically superior processing pressure to the cutting processes;
- the R_a increase observed in the case of the loading forces exceeding with more then 3500N can be appreciated as an anomaly one and can be pouted only on the decreasing of the technological system rigidity during rotorolling account (wave elasto–plastic, by appreciable dimensions, formed in front of the rolls increasing their advancement resistance), the vibra-

tions that appears generate undulations on the processed surfaces so creating deviations with P/H >50;

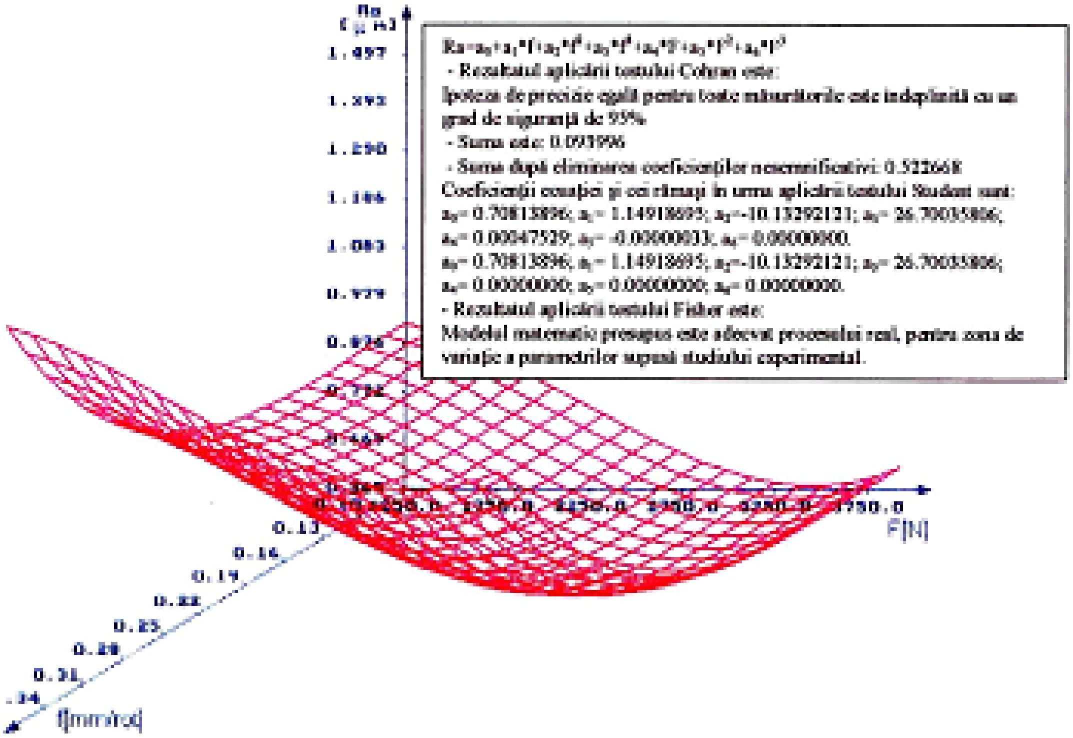

Fig.5.The advances and the push force influences about roughness at the rotorolling steel OL37
(v = 10 m/min = ct.)

- the big proportion microwelds, generated by the high deformation of the material (OL37) contribute, to the shearing's and avulsions so, the combined action of the working advance and of the pressure force, on their increase, does not contributes permanently to the roughness rising.
- the future researches will follow the SCPD through rotorolling influence and over other groups of metallic materials, to make a comparative analysis of their different behavior;
- for the future researches, a particularly interest will be to present the hardening degree stage of the metallic materials pursuant to the rolling application, as a surfaces mechanical treatment.

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REFERENCES

[1] Saturov G.F. *Sposob uprocineniia poverhnosti țilindriceskim instrumentom.* **(1979)** Descrierea invenției 662329;
[2] Duşa Petru Teza de doctorat: *„Contribuții cu privire la studiul procesului de finisare-durificare prin deformare plastică , de dezechilibrare metastabilă a rețelei matriceale, ca proces de influențare a proprietăților mecanice ale acestei matrice.* În „Metalurgia", România, nr.6, 1980, p.311-320;
[3] Lupescu O.et al. *Considerente privind finisarea şi durificarea suprafețelor cilindrice exterioare prin deformare plastică la rece.* În „Construcția de mașini", România, nr.5, 1990;
[4] Lupescu O. Picoş S. et al. *Cercetări privind modelarea preoceselor de prelucrare prin rulare a suprafețelor de revoluție exteriore.* În"Construcția de mașini", România, nr 8-9, 1994;
[5] Lupescu O., *Netezirea suprafețelor prin deformare plastică,* Editura Tehnică info Chişinău (1999) Iaşi. ISBN 9975-910-67-X ;
[6] Wanyorek C. *Coordonarea modificărilor de structură (determinate tehnologic) ale matricei metalice – cu mecanismele prin care se creează, doza, starea, starea de ecruisare, de dezechilibrare metastabilă a rețelei matriceale, ca proces de influențare a proprietăților mecanice ale acestei matrice.* În „Metalurgia", România, nr.6, 1980, p.311-320;
[7] Wisniewski M. *Termomechanical Aspects of Mixed Friction in concentrated Contacts.* In "4 - th European Tribology Congress - EUROTRIB", Elsevier, Ecully – France, vol. II, 1985, cap 5.4.2, p 1-8;