# PROCESS THROUGH PLASTIC DEFORMATION OF THE BEARING RINGS 6210-20

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**ABSTRACT**:
The paper contains data regarding the structural alteration of the material, the shape errors which appear and the roughness state of the bearing rings' surfaces obtained through the cold rolling proceeding to SC Rulmenti SA Barlad from Romania.

**KEYWORDS**: face-milling cutter, continuous sharpening, dismountable teeth

## *1.* INTRODUCTION

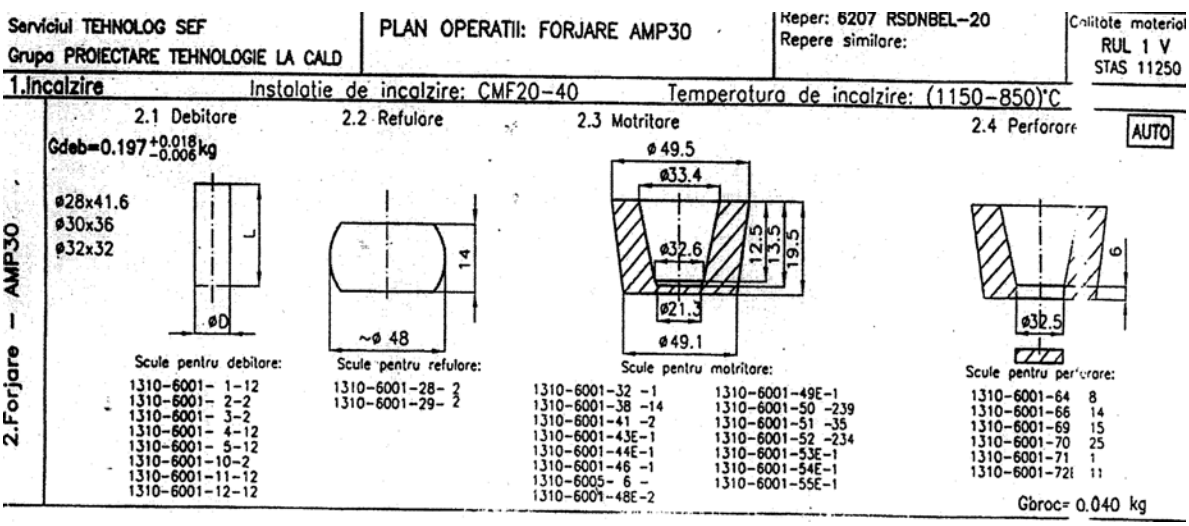
The cold plastic deformation represents today an extremely productive method for pieces with simple geometry, type revolution pieces. The bearing industry took over this method to simplify the technology of the bearing rings. At present they are obtained through the cold deformation, on specialized machines.
Based on the established test parameters, experimental tests have been done on the rings of the 6210-20 bearings (internal ring, on the CRF-70 IR machine).

## *2.* EXPERIMENTATION CONDITIONS

*The material used*
The experimental tests have been done on materials which are specific to the processing of the bearings elements. The following steels are used alloyed with Cr, Mn and Si types 100Cr6 and 100CrMnSi6-4.

*Semi-products*
In table 1 we present the forged piece with all its steps and technical characteristics of the ring on the 6210-20 bearing.

**Table 1. Forged piece ring 6210-20**




*Machine tools*
For the experimental tests there have been used the machines forseen in table 2, whose characteristics are mentioned for the CRF-70 IR machine, and for the CRF-120 OR machine.

*Measuring and control instruments*

To finish the experimental tests through the tracking of the variation of the exit parameters depending on the entry parameters, we used the following instruments:
- the measurement of the roughness has been done with the instrument Taylor Hobson Formtalysurf, series 2;
- the measurement of the micro-roughness has been done with the instrument Akashi MVK-D;
- the measurement of the micro-structure has been done on the instrument Neophot 2 Karl Zeiss;
- the measurement of the bearing race has been done on the instrument Perthometer Marsurf CD 120.

*Character of service*

The experimental tests took place through the use of the established working parameters, that is:
- working pressure, the rolling feed, speed of the drive roller
- to establish the influence of each parameter, for each exit parameter have varied an entry parameter, the rest of two being invariable.
  - after the tests we obtained the results presented in tables 3, 4, and 5 for the 6210-20 ring.
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## 3. THE RESULTS OF THE TESTS

*3.1. Deviations from circularity*

The experimental tests refered to the measurement of the circularity deviations, on the Rank Taylor Hobson device.

*a. The influence of the working force*

In figure 1 it is presented the model of the records for the shape deviations – circularity of the bearing race.

**Table. 2 Technical characteristics of the cold rolling machines**

| CRF 120 OR | | CRF 70 IR | |
|---|---|---|---|
| WORKING RANGE | | | |
| Max. force | 18000kg | Max. force | 7000 kg |
| Maximum external diameter after rolling | 120 mm | Maximum external diameter after rolling | 72 mm |
| Minimum external diameter after rolling | 40 mm | Minimum external diameter after rolling | 30 mm |
| Minimum internal diameter after rolling (internal diameter blank – greater than the width) | 30 mm | Minimum internal diameter after rolling (internal diameter blank – greater than the width) | 15 mm |
| Maximum width | 40 mm | Maximum width | 25 mm |
| WORKING SPEED | | | |
| Forming roller | 127 rpm | Forming roller | 140 rpm |
| Carrying away roller (variable) | 85 ÷ 125rpm | Carrying away roller (variable) | 90÷125rpm |
| FEED | | | |
| High speed feed | 180 mm/min | High speed feed | 180 mm/min |
| Recommended working feed | 30 ÷ 50 mm/min | Recommended working feed | 30 ÷ 50 mm/min |
| SIZING | | | |
| With external bushed bearing | | With internal mandrel | |
| ACTIVE CONTROL | | | |
| Pneumatic turned over with optic rule.<br>System for the elimination of the inadequate pieces before sizing | | | |

**Table 3. Results of the tests with variable force –ring 6210-20**

P = variable A = 30 mm/min – constant V = 118 rot/min – constant

| P [MPa] | $HV_{0,5}$ | | | | | Bearing race | | | | | Dimensions, mm | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | $h_1$ | $h_2$ | $h_3$ | $h_4$ | $h_5$ | Ovality [mm] | Polygon, [mm] | Circularity [μm] | Shape [μm] | $R_a$ [μm] | Dcdr. 57,4 | Dint. 49,65 | H 20,15 |
| $P_1$=4,5 | 270 | 280 | 289 | 291 | 281 | 0,1 | 0,1 | | 14,621 | 0,53 | -0,13<br>-0,23 | -0,23<br>-0,33 | +0,24 |
| $P_2$=4 | 283 | 295 | 301 | 303 | 294 | 0,04 | 0,07 | 52,5 | 13,756 | 0,34 | -0,15<br>-0,19 | -0,29<br>-0,33 | +0,25 |
| $P_3$=3,5 | 274 | 289 | 289 | 290 | 292 | 0,35 | 0,6 | 428,1 | 13,855 | 0,48 | -0,15<br>-0,50 | -0,22<br>-0,60 | +0,30 |
| $P_4$=3 | 272 | 286 | 291 | 281 | 263 | Deform. | Deform. | | 15,898 | 0,62 | Deform. | Deform. | Deform. |

**Table 4. Results of the tests with variable feed – ring 6210-20**

A = variable P = 4,5 MPa – constant V = 118 rot/min – constant

| A [mm/min] | $HV_{0,5}$ | | | | | Bearing race | | | | | Dimensions, mm | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | $h_1$ | $h_2$ | $h_3$ | $h_4$ | $h_5$ | Ovality [mm] | Polygon, [mm] | Circularity [μm] | Shape [μm] | $R_a$ [μm] | Dcdr. 57,4 | Dint. 49,65 | H 20,15 |
| A1=30 | 265 | 270 | 289 | 287 | 281 | 0,21 | 0,28 | 197,25 | 15,0616 | 0,27 | -0,11<br>-0,32 | -0,24<br>-0,58 | +0,25 |
| A2=27,5 | 280 | 283 | 291 | 289 | 268 | 0,22 | 0,28 | 193,9 | 14,110 | 0,26 | -0,13<br>-0,35 | -0,35<br>-0,60 | +0,25 |
| A3=25 | 271 | 281 | 287 | 294 | 289 | 0,07 | 0,09 | 63,2 | 14,806 | 0,27 | -0,14<br>-0,21 | -0,35<br>-0,50 | +0,28 |
| A4=22,5 | 270 | 280 | 290 | 291 | 286 | 0,16 | 0,21 | 183,85 | 14,857 | 0,4 | -0,03<br>-0,19 | -0,40<br>-0,60 | +0,28 |

**Table 5. Results of the tests with variable speed – ring 6210-20**

V = variable P = 4,5 MPa – constant A = 30 mm/min – constant

| V [rpm] | $HV_{0,5}$ | | | | | Bearing race | | | | | Dimensions, mm | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | h1 | h2 | h3 | h4 | h5 | Ovality [mm] | Polygon, [mm] | Circularity [μm] | Shape [(m] | Ra [(m] | Dcdr. 57,4 | Dint. 49,65 | H 20,15 |
| V1=118 | 281 | 283 | 276 | 275 | 282 | 0,09 | 0,07 | 69,50 | 14,448 | 0,21 | -0,11<br>-0,20 | -0,11<br>-0,19 | +0,22 |
| V2=106 | 272 | 298 | 302 | 295 | 290 | 0,18 | 0,18 | 138,5 | 14,474 | 0,25 | -0,13<br>-0,31 | -0,16<br>-0,28 | +0,25 |
| V3=98 | 285 | 306 | 294 | 298 | 312 | 0,08 | 0,12 | 67,65 | 14,710 | 0,23 | -0,06<br>-0,14 | -0,09<br>-0,16 | +0,24 |
| V4=84 | 285 | 291 | 290 | 306 | 298 | 0,30 | 0,28 | 197,35 | 15,723 | 0,40 | -0,05<br>-0,35 | -0,10<br>-0,37 | +0,21 |

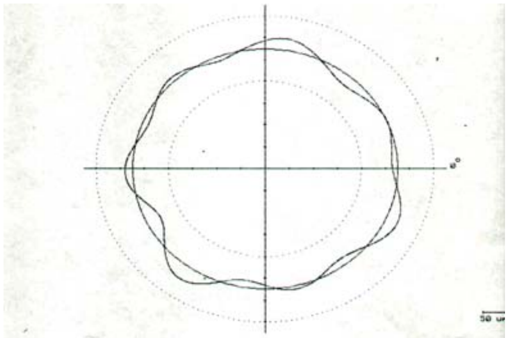


***Fig. 1. Influence of the working force P = 4,5 MPa***

b. Influence of the working feed
In figure 2 it is presented the model of the records for the shape deviations – circularity of the bearing race.

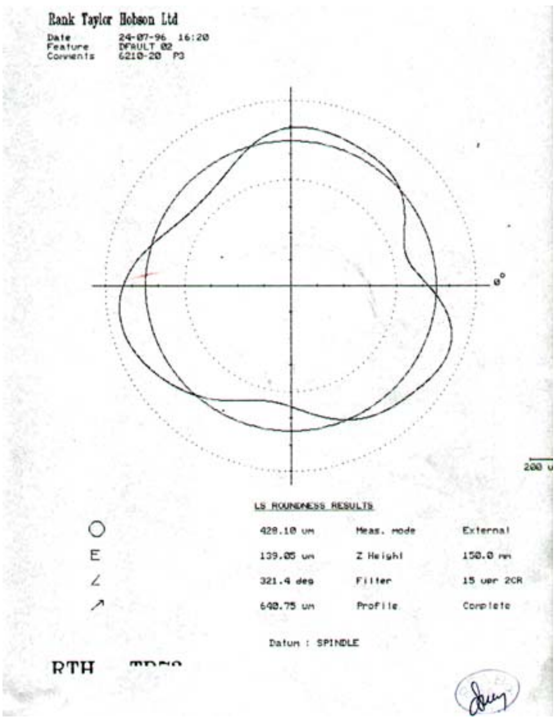


***Fig.2. Influence of the working speed V = 118 rot/min***

c. Influence of the working speed
In figure 3 it is presented the model of the records for the shape deviations – circularity of the bearing race.

*3.2. The roughness of the bearing race*
The roughness of the bearing race has been measured with the Taylor Hobson device.

*a. Influence of the cutting force*
In figure 4 it is presented the model of the records for the bearing race roughness of the 6210-20 rings influenced by the cutting force.

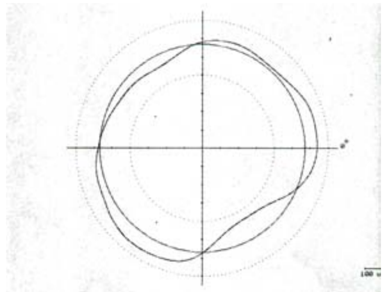

***Fig. 3. Influence of the working feed A = 30 mm/min***

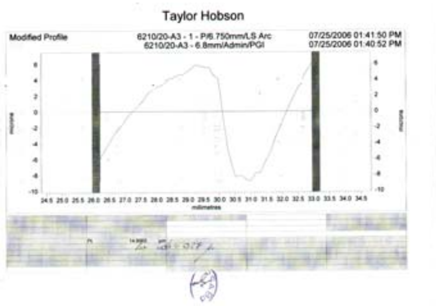


***Fig. 4. Influence of the working feed A = 30 mm/min***

*b. Influence of the working feed*

In figure 5 it is presented the model of the records for the bearing race roughness of the 6210-20 rings influenced by the working feed.

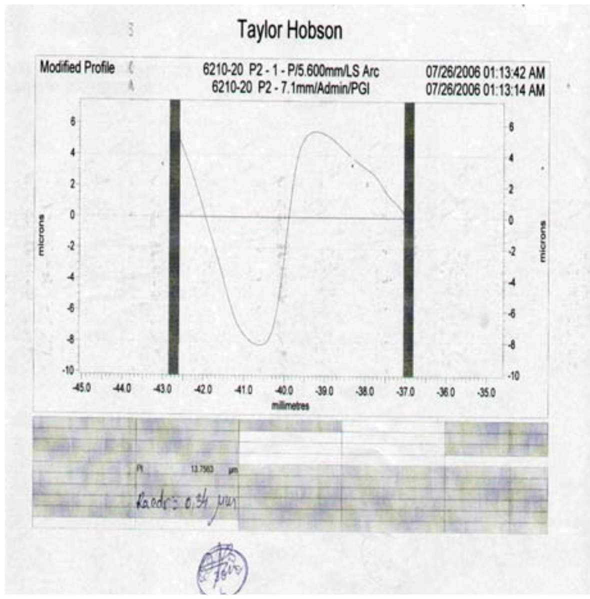


***Fig.5. Influence of the working force P = 4,5 Mpa***

c.- Influence of the working speed
In figure 6 it is presented the model of the records for the bearing race roughness of the 6210-20 rings influenced by the working

speed.

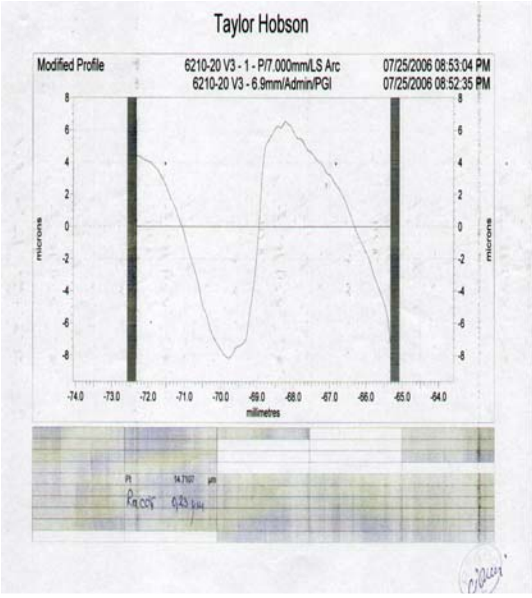


***Fig. 6. Influence of the working speed V = 118 rot/min***

## 4. CONCLUSIONS

Conclusions regarding the influence of the technological elements on the precision and roughness of the bearing race of the 6210-20 rings.

Through the analysis of the experimental tests registered in the tables 3,4, and 5 we can get the following conclusions:

*a. Results regarding the deviations of the bearing race depending on the variable working force*

*a.1. deviations from the circularity and ovality*

In table 3 one can notice that the minimum deviations of circularity 52,5 μm, ovality 0,04 mm and lobed-shape hole 0,07 mm are obtained for the value of the $P_2$ = 4 MPa working force.

*a.2. deviations from shape and roughness*

In table 3 one can notice that the shape deviation $R_t$ = 13,756 μm and roughness $R_a$ = 0,34 μm is also obtained for the working force $P_2$ = 4 MPa.

*a.3. micro-hardness in the bearing race section*

In table 3 one can notice an irregular variation of the micro-hardness. At the surface of the bearing race the maximum micro-hardness $HV_{0,5}$ = 283 is obtained for $P_2$ = 4 MPa.

Based on the results presented we estimate that the corresponding values of the followed parameters appear at the following values of the working parameters: P = 4 MPa, A = 30 mm/min, V = 118 rot/min

*b. Results regarding the deviations of the bearing race depending on the working feed*

*b.1. deviations from the circularity and ovality*

In table 5 one can notice that the minimum deviations of circularity 63,2 μm, ovality 0,07 mm and lobed-shape hole 0,09 mm are obtained for the working feed of $A_3$ = 25 mm/min

*b.2. deviations from shape and roughness*

In table 4 one can notice that the deviation from the right shape $R_t$ = 14,11 μm and roughness $R_a$ = 0,26 μm are obtained for working feed $A_2$ = 27,5 mm/min

*b.3. micro-hardness in the bearing race section*

In table 4 the maximum micro-hardness at the surface of the bearing race of $HV_{0,5}$ = 280 is obtained for the working feed $A_2$ = 27 mm/min

Also the minimum deviations of circularity, ovality and lobed-shape hole are obtained for the working feed $A_3$ = 25 mm/min, one can notice that the difference from the values obtained at $A_2$ = 27,5 mm/min is relatively reduced, we estimate tha the value can be accepted.

Under these conditions the optimum parameters of the working regime through the variation of the working feed are: P = 4,5 MPa, A = 27,5 m,m/min, V = 118 rot/min.

*c. Results regarding the deviations of the bearing race depending on the variable working speed*

*c.1. deviations from the circularity and ovality*

In table 5 one can notice that the minimum deviations of circularity of 67,65 μm is obtained at the speed $V_3$ = 98 rot/min, value wich is very closed to 69,5 μm at the speed $V_1$ = 118 rot/min. The ovality deviations 0,09 μm and 0,07 mm lobed-shape hole are obtained at the working speed of

$V_1$ = 118 rot/min.

*c.2. deviations from shape and roughness*

In table 5 the right shape deviation $R_t$ = 14,448 μm and roughness $R_a$ = 0,21 μm are obtained for the working speed of $V_1$ = 118 rot/min.

*c.3. micro-hardness in the bearing race section*

In table 5 the micro-hardness at the surface of the bearing race varies from $HV_{0,5}$ = 272 to 285. Because the difference between those is relatively reduced, one can appreciate that at the working speed of $V_1$ = 118 rot/min the value of the micro-hardness $HV_{0,5}$ = 281 is acceptable.

Based of these data the working parameters to obtain the corresponding conditions for the deviations of the bearing race are:

P = 4,5 MPa, A = 30 mm/min, V = 118 rot/min.

Through the analysis of the data obtained depending on the variation of the working parameters on the deviations of circularity, ovality, lobed-shape hole, shape, rough ness and micro-hardness of the bearing race, the optimum regime which must be used on the machine is: P = 4 MPa, A = 27,5 mm/rot, V = 118 rot/min.

## 5. REFERENCES

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# MODELLING OF STRESS CONDITION OF SURFACE LAYER BY ULTRASONIC STRENGTHENING PROCESSING

**A. Polovinkin, V. Makarov**

**Abstract**

Effective way of improvement of operational properties of the details made of different marks steels and alloys is hardening their superficial layers, including with use high concentrate energy sources. In this paper results of research of process of ultrasonic strengthening finishing processing with use of a finite elements method are submitted. Mathematical dependences of interaction of the concentrator with a surface of workpiece and as results of experimental researches are submitted at hardening heat-resistant steels which used at manufacture of gas turbine engines.

**Keywords**: SPD - superficial plastic deformation, USFP - ultrasonic strengthening finishing processing, the concentrator.

## 1. INTRODUCTION

One of fundamental problems of machine-building manufacture is necessity of martempering quality, a heightening of productivity, increase in longevity and reliability of machines wares.
These indexes in basic are ensured on finishing operations at the expense of quality management of a surface stratum and reaching of tall operating performances of work pieces in a completing stage of their manufacture.
Reaching of tall operating performances of workpieces is ensured owing to application of strengthening machining.
One of directions of a development of ways of strengthening is creation of an opportunity of control in parameters of a surface layer (depth, degree and uniformity of strengthening, and as microgeometry of a surface) in a wide range.
At SPD the ultrasonic instrument speed-torque characteristics are improved such as strength and hardness that is consequence of growth of a density of dislocations raise.
In hardened steels to this process transition of residual austenite in martensite is added, that as considerably raises their speed-torque characteristics.
In heat-resistant steels and alloys there are interphase microstresses and, presumably, there is a seal of structure.
The given kind of processing has external similarity to process of smooth by rolling. Difference consists that the concentrator makes compulsory fluctuations with the certain amplitude and frequency in a direction of a normal to a processable surface (Fig. 1). The concentrator has frequency of fluctuations 20 kHz. Such
frequency of fluctuations is created by means of transformation of a current with frequency of 50 Hz the generator of semi-conductor type which is connected to the ultrasonic head established on the machine tool.
In the case of the ultrasonic head it is located magnetostrictor due to which mechanical fluctuations with similar frequency are achieved. Thus process of hardening grows out short-term bangs. An interval of time of bang $5 \cdot 10^{-5}$ sec. During the certain part of the period contact between the tool and a processable surface is absent, and at the moment of contact instant pressure are much higher than average, as results in the much greater plastic deformation, than at usual smoothering or running.
On open joint-stock company «Perm engine company» researches of influence of parameters of modes of processing USFP on quality of a superficial layer of the samples made of heat resisting alloys have been carried out.
It has experimentally been established, that the range of district speed lays within the limits of 20 - 25 m/minutes. At decrease of district speed improvement of quality of a surface is insignificant besides productivity of processing whereas the increase over 35