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DEVELOPMENT OF THE STANDARD PROCESS PLANS FOR ROLLING BEARINGS MANUFACTURING

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Abstract: *Demands of modern market are oriented towards quick production program change, shortening of delivery intervals, quality raising and lowering of the product price. Satisfaction of market requirements demands improve all functions inside the production system, especially the product preparation. This paper introduces basic analysis of the process plans for rolling bearings production from FKL Company and information about development standard process plans for manufacturing of ball, cylindrical roller, spherical roller and needle roller bearings from this manufacturing systems. Standard process plans for rolling bearing manufacturing are fundament of organization of manufacturing of these products.*

Key words: *rolling bearings, standard process plans, analysis, development.*

1. INTRODUCTION

In modern conditions of business activities, production systems are forced to redesign their production processes, or made their reengineering, in accordance with the diverse of needs and demands of the market. One of the main directions is technological process reengineering, which involves development and improvement of technological processes of manufacturing, development of the technological database, the application of modern and more efficient usage of existing production and technological resources, determining the real technological norms, more effective job preparation, etc.

The subject of this paper is the analysis of existing technological processes for rolling bearings manufacturing, as the layers for the development of standard technological processes of their production. Development of standard technological process is based on the concept of typical and group technology.

In the development of standard technological processes, except assortment of rolling bearings production and volume of production, it is also necessary to take into account the technological and installed equipment for the production of bearings.

In the development of standard technological processes of rolling bearings production the most important goals are:

- more efficient organization and implementation of technology and production processes,
- better planning and management of production,
- reduced number of technology flows,
- better planning and control of usage of technological capacity,
- increased flexibility to market demands,
- efficiency of technological preparation of production.

2. SHORT REVIEW ON PRODUCTION PROGRAM OF ROLLING BEARINGS

Based on the analysis of rolling bearing production for 2008 year, it was determined a quantity, i.e. realized production volume, as for individual bearings, as for the total volume of production for the formed group, and the results of this analysis are given in Table 1.

Within this analysis it was determined a realized amounts for the production of above mentioned types of bearings, and with the application of ABC analysis it was determined the representative products for the individual groups of bearings, which are shown in detail in the project [1]. In this paper it will be shown necessary information for the selection of representative product for cylindrical roller bearings.

In Table 2 it is shown a production program of cylindrical roller bearings for 2008. year, on the basis of which was made quantitative, mass and value ABC analysis, Figs. 1, 2 and 3.

As can be seen from the diagram for volume ABC analysis (Fig. 1), diagram for mass ABC analysis (Fig. 2)

Table 1

Production program of rolling bearings for 2008

MARK OF THE GROUP	BEARING GROUP	NUMBER OF TYPISIED BEARINGS IN GROUP	OVERALL PRODUCTION VOLUME (piece/year)
A	Cylindrical roller bearing	8	401619
B	Spherical roller bearing	7	294
C	Double row rolling bearing	2	29335
D	Single row deep groove rolling bearing	12	353455
	Single row angular contact rolling bearing	10	
E	Single row angular contact rolling bearing with grub set screws	7	352674
F	Needle roller bearings	1	669

Table 2

Production program of cylindrical roller bearings

Product	Identification number	Mark	Quantity piece/year	Mass kg/piece	Price €/piece
P1	501219	NF 310	171	1.17	17
P2	501223	NP 208	48	0.5	9.8
P3	520264	NJ 203 ECP	200000	0.0705	5.6
P4	520060	NJ 204 M *YU	6	0.11	4.8
P5	501220	NJ 205	3	0.138	5.7
P6	520034	NJ 304	75	0.152	5.8
P7	520035	NJ 2205 *YU	23	0.171	7
P8	501222	NJ 2207	26	0.41	9.2
P9	520223	NJ 2208	2	0.55	13.5
P10	520274	NJ 2203 ECP	200000	0.0945	18.1
P11	501341	NJ 2309 *YU	8	1.5	18.9
P12	520136	NU 206 EP	13	0.206	6
P13	520016	NU 210 *YU	26	0.49	9.5
P14	520023	NU 2309 *YU	2	1.4	17.8
P15	520164	NUP 206 EPX	381	0.22	7.7
P16	520120	NUP 216 ER.M.C3	18	1.64	61.8
P17	520046	NUP 309 N.VH.C3	97	1.05	14.4
P18	502040	NUP 314 EN.M.C3	60	2.83	64
P19	502040	NUP 89/178/84 V.C3	654	11.64	133.7
P20	520257	NUP 2206.S2	6	0.27	10.7

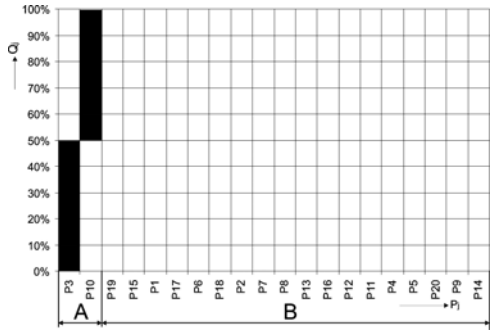

Fig. 1. Diagram for volume ABC analysis of cylindrical roller bearings.

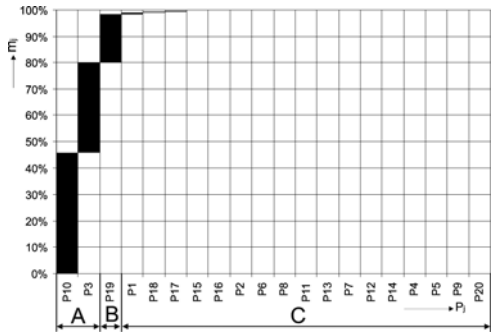

Fig. 2. Diagram for mass ABC analysis of cylindrical roller bearings.

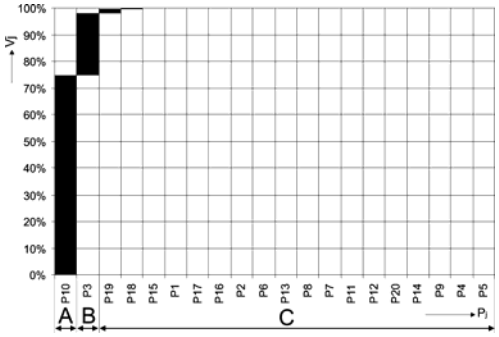

Fig. 3. Diagram for value ABC analysis of cylindrical roller bearings.

and diagram for value ABC analysis (Fig. 3), a product NJ2203 ECP (P10) in all three cases is located in the A area of presented ABC analysis, on the basis of which it is chosen for the representative product for group of single row cylindrical roller bearings. Fig. 4 shows` representative products for six formed groups of rolling bearings which are selected by applying ABC analysis [1].

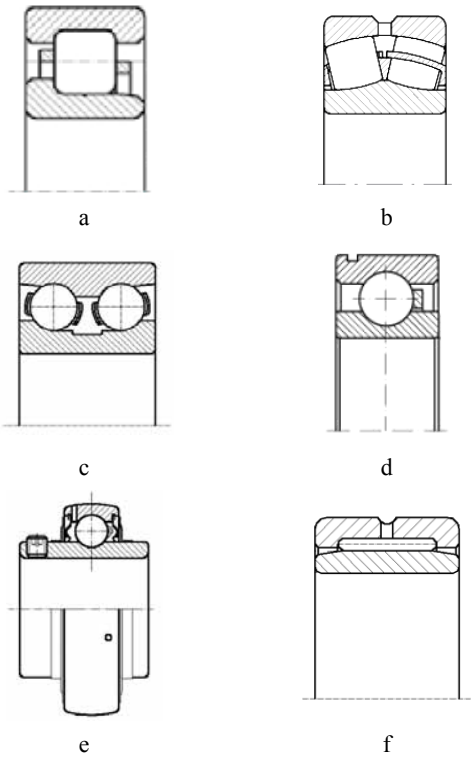

Fig. 4. Representative products for formed groups of rolling bearings: a) Cylindrical roller, b) Spherical roller, c) Double row ball, d) Single row deep groove ball and Single row angular contact ball, e) Single row angular contact ball with grub set screws, f) Needle roller bearings.

Geometric similarity of external and internal rings of rolling bearings, especially the geometric identity of typical structural solutions in the formed groups, allow to define the layers for the development of standard technological processes of manufacturing, based on the principles of typical and group technology.

Formed groups of rolling bearings, which are consist from numerous standardized construction solution with a broad range of dimensions [5], given volume production of bearings and installed technological equipment, are the basis for defining layers for the development of standard technological processes of manufacturing.

Development of standard technological processes of manufacturing for rolling bearings in observed production system, as the object of research in this paper, refers to standard technological processes of manufacturing for the rings of certain bearings, while the other positions will not be considered here.

3. LAYERS FOR THE DEVELOPMENT OF STANDARD TECHNOLOGICAL PROCESSES

In terms of the observed production system, for the observed rolling bearings, can be defined rough order of operations:

- Parting off,
- Turning,
- Drilling,
- Threading cutting,
- Heat treatment,
- Grinding facet,
- Grinding outside,
- Roll track grinding,
- Grinding openings,
- Super-finishing,
- Demagnetization,
- Final control.

Volume of production, types of raw material and dimensions of the rings from observed groups of rolling bearings require alternative technological solutions in the key processing operations, such as processing of turning, grinding and super-finishing.

3.1 Rules for the raw material selection

For processing of the external and internal rings of rolling bearings can be used different types of steel raw material, depending on the volume of production and dimensions of the rings, i.e. internal and external diameter and width of the ring, according to the Fig. 5.

For the selection of optimal variant of raw material it is necessary to perform techno-economical analysis of production costs as a criterion of optimization. In essence, this criterion determines as the most advantageously raw material is, except for the fulfillment of technical requirements, that which has the lowest cumulative cost raw material value Cp and cost of the technological process of manufacturing U, i.e. [3]:

$$Cp + U \rightarrow \min. \quad (1)$$

Depending on the selected type of raw material, volume of production and ring dimensions of the corresponding group of rolling bearings, it exist a different technological solutions of processing operations. The largest variability with a greater number of alternative solutions is appearing at the turning and grinding operations, as the vital operations for ring processing.

In the resumption it will be shown a development of layers for the selection of machining systems for the above mentioned processing operations. Defining of rules for the selection of appropriate technological solutions, i.e. the selecting of machining systems for these processing operations, create the layers for the development of standard technological processes of production, because other operations which are part of typical and group technological process remain the same.

3.2 Layers for the selection of machining systems for rings turning

Depending on the volume of production and ring dimensions of the bearings, at Fig. 6 are defined layers for the selection of machining systems for the operation of turning, with the corresponding internal names and labels.

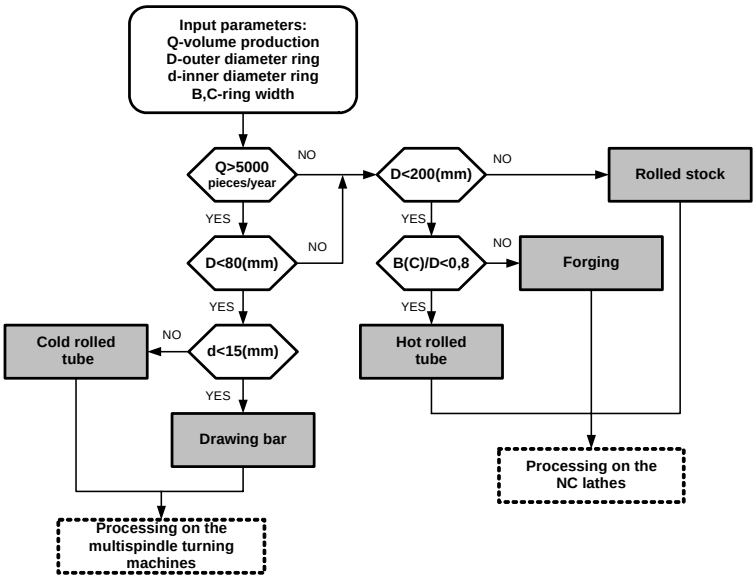

Fig. 5. Rules for raw material selection for manufacturing of ring from rolling bearing.

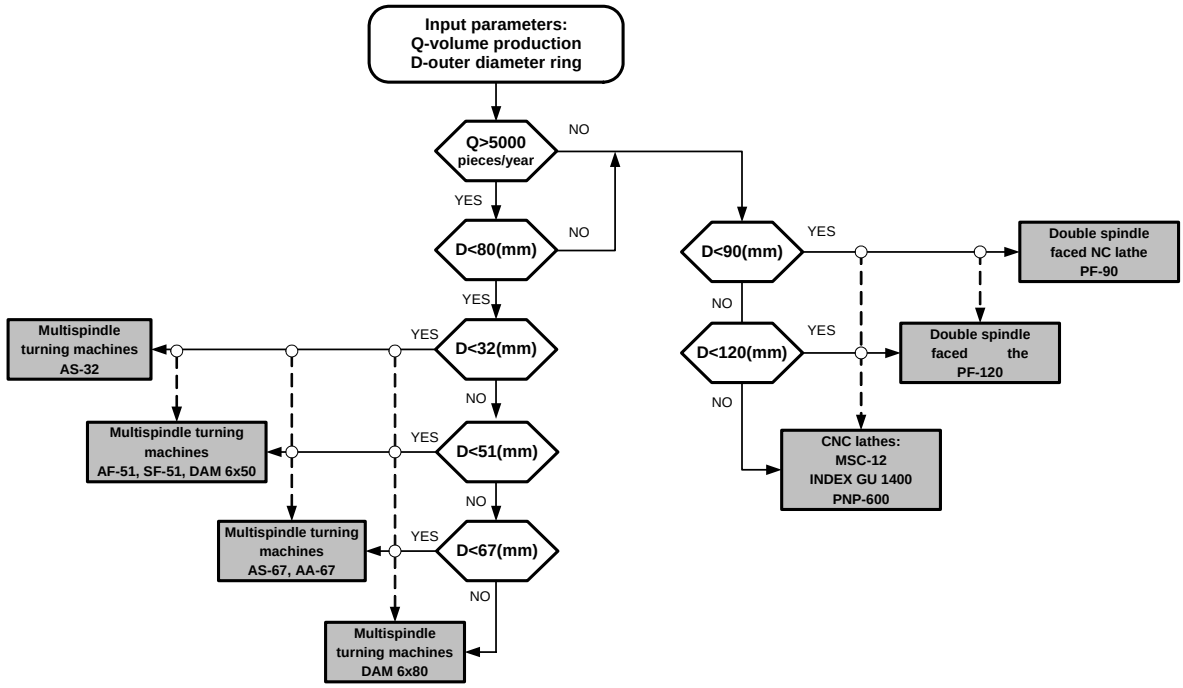

Fig. 6. Rules for machining system selection for turning of ring from rolling bearing.

3.3 Layers for the selection of machining systems for external ring grinding

External ring grinding includes three processing operations, i.e. grinding facet area, outer diameter and roll tracks.

Selection of machining systems for grinding flat or facet area, are based on the external diameter (D) and width (C), Fig. 7.

Selection of machining systems for grinding outer diameter of outer ring is made on the basis of the layers given in Fig. 8, depending on the shape and diameter of the outer surface.

Grinding of roll track, as profile area at outside ring, machining systems can be chosen on the basis of layers, which are shown at the Fig. 9.

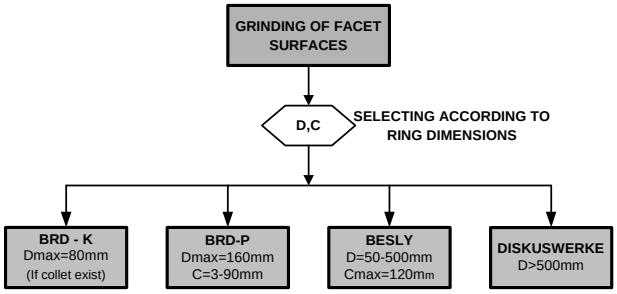

Fig. 7. Layers for selection of machining systems for grinding facet area at outer ring.

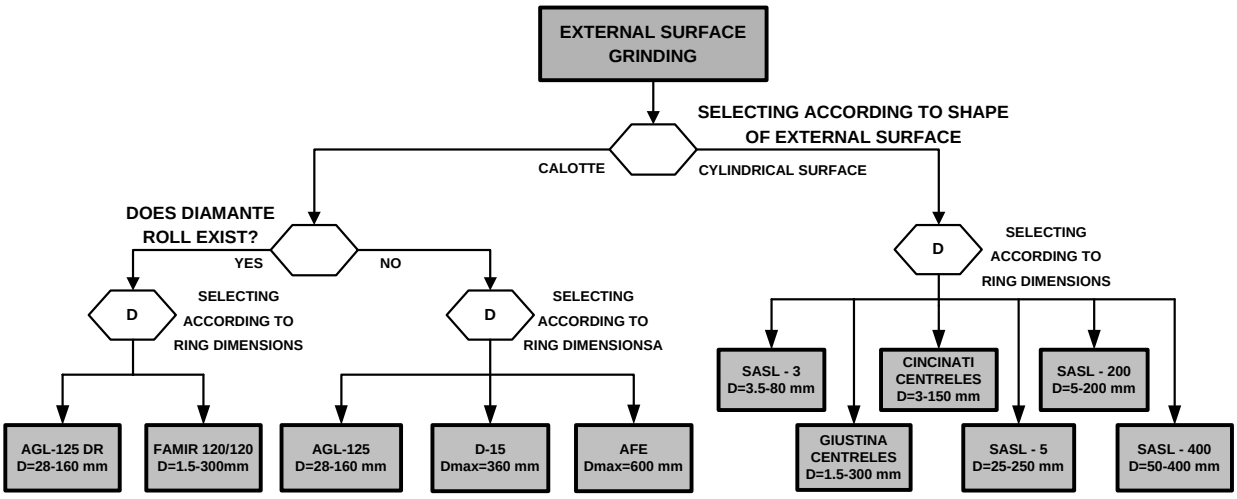

Fig. 8. Layers for selection of machining systems for grinding of outer surface at outer ring.

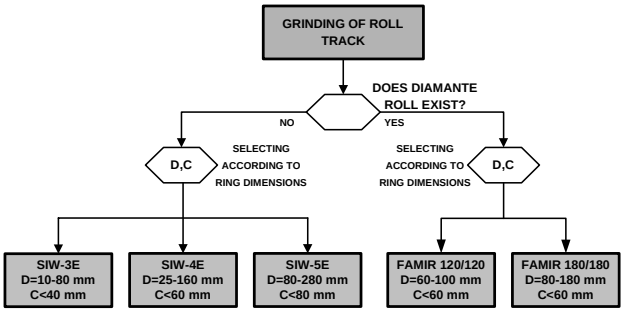

Fig. 9. Layers for selection of machining systems for grinding of roll track at outer ring.

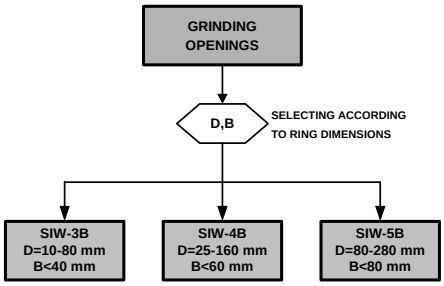

Fig. 13. Layers for selection of machining systems for grinding openings at inner ring.

3.4 Layers for the selection of machining systems for inner ring grinding

Grinding of inner rings includes grinding of facet area, external surface, roll tracks and grinding openings.

Selection of machining systems for flat grinding facet surface at inner ring, according to Fig. 10, are based on the diameter and width of the ring, and for grinding of outer surface selection of machining systems is done based on the external diameter of the inner ring, the Fig. 11.

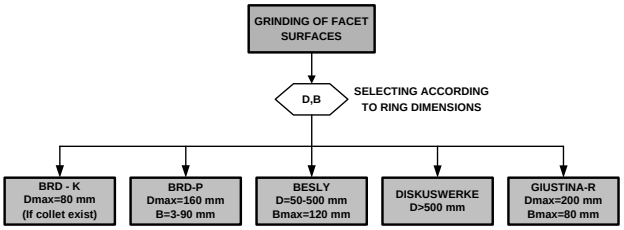

Fig. 10. Layers for selection of machining systems for grinding facet area at inner ring.

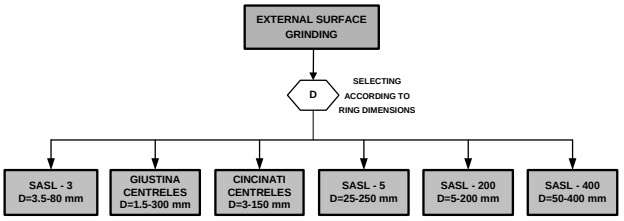

Fig. 11. Layers for selection of machining systems for grinding of outer surface at inner ring.

Selection of machining systems for grinding roll track and grinding openings at inner ring is done, according to the Figs. 12 and 13, on the basis of diameter (D) and width of the ring (C).

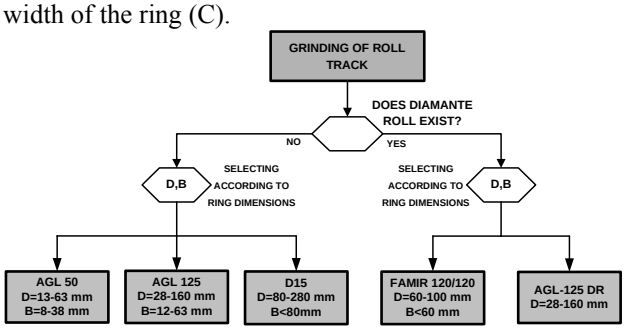

Fig. 12. Layers for selection of machining systems for grinding of roll track at inner ring.

3.5 Layers for the selection of machining systems for super-finishing of roll track

Selection of machining systems for processing of roll track with super-finishing, are done, for the outer ring on the basis of layers that are shown at the Fig. 14, and inner ring on the basis of layers that are shown at the Fig. 15.

In both cases the selection of machining systems are based on the external diameter (D) and width of the ring (C), or (B).

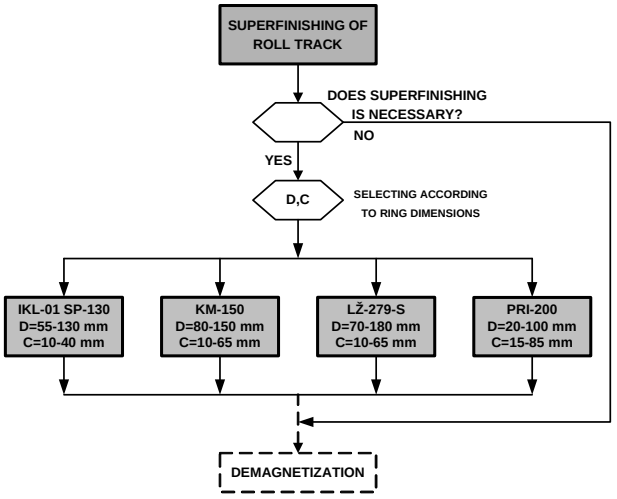

Fig. 14. Layers for selection of machining systems for superfinishing of roll track at outer ring.

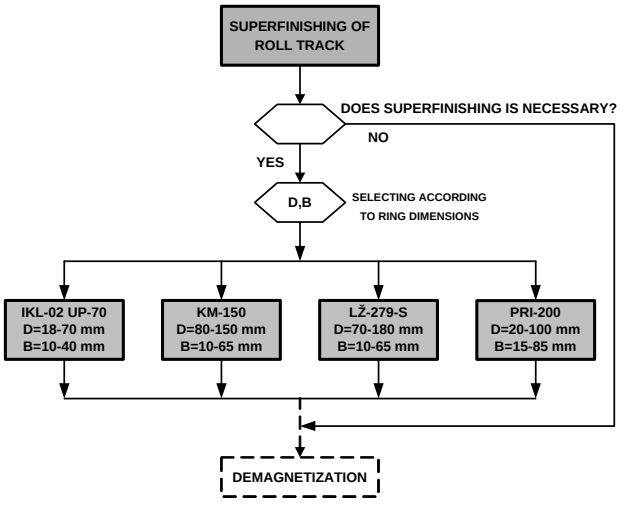

Fig. 15. Layers for selection of machining systems for superfinishing of roll track at inner ring.

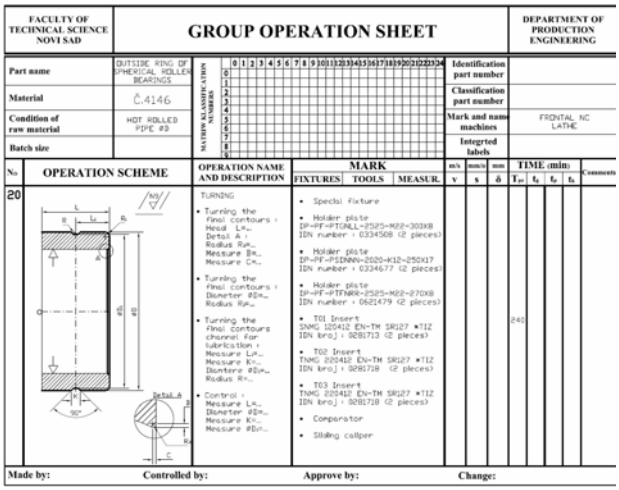

Fig. 16. Group operation sheet for turning of outside ring from group of spherical roller bearing.

Thus defined layers for the selection of machining systems for operation of turning, grinding and super-finish, enable for the group of rolling bearings, which are covered with this analysis, effectively defining of suitable standard technological processes of manufacturing, which enables fast refinement of technological process for each bearing.

Formed groups of rolling bearings, volume of production, technological equipment and layers for their selection, as well as the existing individual technological processes, are the basis for the development of standard technological process of manufacturing.

In the scope of project [1] it was developed a standard technological process for the six groups of early mentioned rolling bearings and it was carried out the refinement of technological process for the appropriate representative products of these groups.

At Fig. 16 it is shown the group operation sheet for the standard technological processes of outside ring production from group of double row spherical roller bearing, which are related to the operation of turning on the appropriate double-spindle faced NC lathe.

4. CONCLUSIONS

Developed layers for selection of machining systems for operation of turning, grinding and super-finishing of bearings rings enable the development of standard technological process of manufacturing for these products in observed production system.

Standard technological processes of manufacturing of bearings, which are developed by applying the concept of typical and group technology, as well as layers for the selection of machining systems on the mentioned key operations, make solid base for the development of systems for automated design of technological processes of manufacturing of these products, and the corresponding CAPP system.

On the basis of standard technological process for the six groups of rolling bearings, it is possible to accelerate the process of refinement technological processes for all the bearings in certain groups, and of course, for the representative products of these groups.

Refinement (precisely) technological processes for the representative products enable, that on the basis of reducing quantities, easy way to planning of limits of organization and realization of production process, as well as effective monitoring and planning of utilization installed technological capacity and human resources.

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