Ministry of Education and Science of Ukraine
Ternopil Ivan Pul'uj National Technical University
(full name of higher education institution)
Engineering of Machines, Structures and Technologies
(faculty name)
Mechanical Engineering Technologies
(full name of department)

EXPLANATORY NOTE

for diploma project (thesis)

bachelor
(educational-proficiency level)

topic: **Improvement of the shaft 47.628.007 machining production process**

Submitted by: fourth year student group IMP-42
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131 «Applied Mechanics»
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Ternopil
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Faculty *Engineeringof Machines, Structures and Technologies*
Department *Mechanical Engineering Technologies*
Educational degree *Bachelor*
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APPROVED BY
Head of Department *Okipniy IB*

Assignment

FORQUALIFICATION PAPER (THESIS) FOR STUDENTS

Saleem Mohamed Ajajii
(surname, name, patronymic)

1. Project (thesis) theme. **Improvement of the shaft 47.628.007 machining production process**

Project (thesis) supervisor *Prof., Vasylkiv VV*
(surname, name, patronymic, scientific degree, academic rank)

1.Approved by university order as*12/31/2021 No. 4/7-1178*
2. Student's project (thesis) submission deadline 24 th of June 2022
3. Project (thesis) design basis *Drawing of the part.*
Basic technological process. Annual production program.

4. Contents of engineering analysis (list of issues to be developed)
General-technicalchapter. Analysis of part design and basic technological process of its manufacture.
Technologicalchapter. The choice of method of manufacture of the workpiece. Development of operational technological process. The calculation of the cutting conditions. Rate setting of operations.
Designingchapter. Choice and design description of attachments. Tools, materials and appliances for the manufacture of the case.
Safety measures.
5. List of graphic material (with exact number of required drawings, slides)
Case, case (workpiece) - A1.
Routing technological process of manufacturing part – A1.
Technological attachment–1A1.
Designing scheme of the tool – 1A1.

6. Advisors of design (thesis) chapters

Chapter	Advisor's surname, initials and position	Signature, date	
		assignment given	assignment accepted
Safety measures	*ProfessorValery Lazariuk*		

7. Date of receiving the assignment *25 th of June 2022*

PROJECT TIME SCHEDULE

LN	Diploma project (thesis) stages	Project (thesis) stages deadlines	Notes
1	*General-technical chapter*	05/16/2022	
2	*Technological chapter*	06/07/2022	
3	*Designing chapter*	06/14/2022	
4	*Safety measures*	06/28/2022	
5	*Drawings*	07/4/2022	

Student ____________ *Saleem Mohamed Ajajii*
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Project (thesis) supervisor ____________ *Vasylkiv VV*
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CONTENT

INTRODUCTION

The intensity of production in the field of mechanical engineering is connected with the technical conversion and modernization of the means of production based on the use of the most modern developments and technologies. Technical conversion, preparation for the production of new types of machine-building products and modernization of production means includes the processes of designing technological equipment and its manufacture.

In the total volume of technological equipment, approximately 50% are machine tools. Machine tools allow you to reliably base and fix the workpiece, so that the processing process is stable and depends at least on the qualification of the worker. This allows fairly consistently high quality of processed parts.

Depending on the type of production, the technical level and structure of machine tools vary. In most cases, special devices for machines are used for mass and serial production. These devices have one purpose for performing certain operations of mechanical processing of a specific part.

1 GENERAL TECHNICAL PART

1.1 Official purpose and characteristics shaft 47.628.007. Analysis of technical conditions

Shaft 47.628.007is a component of the fan of the crop sprayer. The material of the shaft is steel 45 according to DSTU 7809.

He belongs to the class of parts 71 - bodies of rotation, subclass "Shafts" according to its structural and technological features of the part.

Two necks are the main design bases in the detail $\varnothing 45 js6(\pm 0.008)$ and $\varnothing\ 40 js6(\pm 0.008)$ along which it is based in the gearbox housing through rolling bearings.

On the neck $\varnothing 17 p6(^{+0.035}_{+0.022})$ is based on the eccentric, which drives the plunger pump. The torque between it and the shaft is transmitted by a prismatic key under which a keyway with a width of 6.0 mm is provided. and 32.0 mm long. In the axial direction, the eccentric is fixed with a round slotted nut according to GOST 11871-73, for which a thread is provided $M24´1,5$. The nut is locked with a washer for the legs, which has a groove 7 mm wide, 2.5 mm deep and 18.0 mm long on the threaded neck.

Slots $\mathrm{D} - 8 \times 42 \times 48\mathrm{h}6 \times 8\mathrm{h}7$ serve to base four gear wheels and transfer torque to them.

After getting acquainted with the structural features of the part, we conduct an analysis of technical conditions, during which we identify the technological problems of processing the part. We choose methods of final processing and methods of control of technical requirements, determining the most suitable surfaces.

A number of technical requirements are set for the production of the drawing part, the content and analysis of which are given in Table 1.1.

Table 1.1 - Technical requirements for manufacturing a shaft

The content of the technical requirement	When and how a technical requirement is satisfied	Method and means of technical requirement control
$\boxed{\nearrow}\boxed{0.04}\boxed{AB}$ End beating of the ends of the slots relative to the axis of the part (base AB) no more than 0.04 mm.	Grinding of the indicated ends in the centers	In control centers, a clock-type indicator.
$\boxed{\nearrow}\boxed{0.04}\boxed{AB}$ Radial beating of necks and of the outer surface of the slots relative to the axis of the part (base AB) no more than 0.04 mm.	Fine grinding of the specified surfaces in the centers.	In control centers, a clock-type indicator.
Coating by chemical oxidation with oiling	In baths for applying chemical coatings.	Visual control
Hardness 28...30 HPЭ.	Thermal improvement (quenching and high tempering)	Hardness meter $TK-14-250$ $GOST\ 23677-79$

1.2 Analysis of the manufacturability of the design of the part

The drawing shows all tolerances of size, shape and mutual placement of surfaces, as well as surface roughness parameters. The drawing contains information about the material of the product and the required heat treatment. The workpiece of the part is a hot-rolled rolled product. The part is technological and allows you to realize the process of its high-performance processing using modern equipment.

1.3 Analysis of the basic manufacturing process of the part

The technological process is characterized by a low labor intensity and a short main time, which is necessary for the production of a part in one or another operation.

The described technological process is not characterized by a large amount of material equipment.

All operations of mechanical processing of the part are carried out in one workshop of the plant, which made it possible to reduce the time for transportation of parts to the mechanical processing section.

The technological process consists of many machining operations. These are turning and screw cutting (on a 16K20P machine), circular grinding (on a 3M132 machine), (on a 2732 PVC machine), vertical milling (on a 6P21 machine), milling (on a model8A632), locksmith shop. And also from auxiliary operations, such as moving the part, washing, technical control.

Operation 010. Lathe (processing of the contour of the part and the bases that will be used later to install and secure the part in technological devices).

Operation 020. Circular grinding (grinding of the main responsible surfaces of the part).

Operation 030. Vertical milling (milling of a keyway with a width of 6 mm).

*Operation 040.*Slot milling machine (milling of 8 slots $D-8\times42\times48h6\times8h7$).

We can combine some operations of this technological process into one, which makes it possible to reduce the time for mechanical processing and reduce the number of metal-cutting equipment. Also, we can process the part in one facility, which will ensure greater accuracy of the part's manufacture.

The use of newer equipment will make it possible to increase the accuracy of achieving the dimensions of the part, reduce allowances for mechanical processing, use more productive cutting modes, which in turn will make it possible to reduce the total time for the production of this part.

1.4 Conclusions and setting of problems for the thesis

The main task of diploma design is to improve the existing one technological process of manufacturing the part. To do this, it is necessary to choose the optimal method of obtaining the workpiece, choose technological bases, choose the optimal technological route for the production of this part from the point of view of economy, productivity and accuracy of processing.

For the selected route, it is necessary to calculate allowances for processing and interoperational dimensions, design the workpiece. In the design process, it will be necessary to solve such engineering problems as calculating the dimensions of the part, choosing a cutting and control-measuring tool, calculating cutting modes and processing time standards. It will be important to choose the right technological equipment, organize its work, ensure its effective use in terms of power and working time.

In the course of the diploma project, it will be necessary to design control devices, automation tools to ensure efficient and accurate processing of the part, conduct calculations necessary for the design of the mechanical processing section, consider measures to ensure safe working conditions, as well as calculate the economic efficiency of the adopted design decisions.

The main result of the work will be the developed technological process of manufacturing the shaft47.628.007, designed in the form of a set of technological documentation, as well as drawings of special machine tools and control devices with specifications, maps of settings for technological process operations.

2 TECHNOLOGICAL PART

2.1 Selection of the method of obtaining the shaft blank

The material of the part is carbon steel 45DSTU 7809, which has unsatisfactory casting properties with increased plasticity in the processes of its pressure treatment. Analogues of this material are steel 1044, 1045, 1.0503. Therefore, the main method of obtaining a workpiece is the method of processing metals by pressure, which contains many methods of implementation.

Since, according to the task, the type of production is medium series, the most expedient is the option of obtaining a billet from hot-rolled rolled steel in accordance with GOST 2590-88.

We developed a working drawing of the shaft in the process of completing the diploma project, therefore, to determine its weight, we created a solid model of this part in the SolidWork system. We determined the characteristics of such a part: the volume is 0.00054 m3, the mass is 4.25 kg [20-25].

We determine the diameter of the rolling stock for the workpiece:

$$D_{pr} = D_l + 2 \cdot Z \ , \tag{2.1}$$

where D_l is the maximum diameter of the limiting surface of the part, $D_l = 55\ mm$;

2Z is an allowance for the processing of this surface, since this surface is not working, it has a small length, so in order to save metal, we leave it untreated, 2Z = 0 mm.

$$D_{pr} = 55 + 0 = 55 mm$$

We accept the standard value, D_{pr} =5.5 cm.

We determine the length of the workpiece obtained from rolling:

$$L_{pr} = L + 2 \cdot Z \ , \tag{2.2}$$

where L_{pr} is the length of the part, L= 0.395 m.

Z- end allowance, Z = 2.5 mm.

$$L_{pr} = 395 + 2 \cdot 2,5 = 400\,mm$$

We reconcile this value with tabular data of a normalized series of linear sizes; thus L_{pr} =0.4 m

We determine the weight of the artificial workpiece according to the formula:

$$Q_{pr} = \frac{3,14 \cdot D_{pr}^2}{4} \cdot L_{pr} \cdot \rho\,, \tag{2.3}$$

where ρ is the density of the workpiece material: ρ = 7.8 g/cm^3.

We get by substituting the values:

$$Q_{pr} = \frac{3,14 \cdot 5,5^2}{4} \cdot 40 \cdot 7,8 = 7408\,г \approx 7,4\,кg$$

Then we determine the metal utilization factor:

$$K_{vm} = \frac{q}{Q_{pr}} = \frac{4,25}{7,4} = 0,57$$

where q is the mass of the part, according to the drawing $q = 4,25$kg;

We determine the cost of the billet from the roll:

$$S_{pr} = M + C_o\,, \tag{2.4}$$

where M is the cost of the workpiece material, UAH;

C_o is the technological cost of the operation of cutting the rolled steel into artificial blanks (we do not foresee the straightening of the rolled steel due to its relatively large diameter with a short length of the blank).

We determine the costs of the workpiece material:

$$M = Q_{pr} \cdot S - (Q_{pr} - q) \cdot S_{waste}\,, \tag{2.5}$$

where S and S_{waste} are the cost of 1 kg of workpiece material (S = 24 UAH) and 1 kg of waste material (S_{waste} = 3 UAH), respectively;

$$M = 7,4 \cdot 24 - (7,4 - 4,25) \cdot 1 \approx 156,05\ UAH$$

We define the technological cost of the operation of cutting rolled steel into artificial blanks:

$$C_o = \frac{C_{pz} \cdot T_{sht.k}}{60}, \qquad (2.6)$$

where C_{pz} is the stated costs, C_{pz} = 42.3 UAH/hour (cutting on machines that work with disc saws);

$T_{sht.k}$ – artificially calculated time of the cutting operation. We define it by the approximate formula [1]:

$$T_{sht.k} = 0{,}011 \cdot D_{pr} \cdot \phi_{sht.\kappa} = 0{,}011 \cdot 55 \cdot 1{,}84 \approx 1{,}11 \text{ min}. \qquad (2.7)$$

where φ_{PC} – coefficient of artificial calculation time, for milling machines φ_{PC} = 1.84 [2]

$$C_o = \frac{42{,}3 \cdot 1{,}11}{60} = 0{,}78 \ UAH$$

Thus, the cost of a rolled blank is as follows:

$$S_{pr} = 156{,}05 + 0{,}78 = 156{,}83 \ UAH$$

2.3 Selection of processing methods, technological and measurement bases

Sketches of processing by operations and technological bases are given in the appendix.

2.4 Formation of the route-operational technological process of manufacturing the shaft

The shaft processing route was summarized in table 2.1.

Table 2.1 – Basic shaft manufacturing route

The operation and its summary by transitions	Machine model	Technological equipment
1	2	3
005 Moving Transport the workpiece to the site.		EK-2
010 Milling and cutting 1. Cutting the workpiece in the size D = 55 mm and L = 400 mm	Milling and cutting 8A631	Device at the machine
020 Heat treatment Improvement, HB 240...280	Thermal oven	
025 Turning and screw-cutting machine 1. Trimming the ends with an allowance of 2.50 mm in size 395 mm 2. Drilling the central hole B4 GOST 14034-74.	Lathe and screw-cutting machine model 16K20P	Self-centring three-jawchucks $GOST\ 2675-80$
030 Turning and screw-cutting machine 1. Turning of surface 1 to a length of L=$315{,}5$ mm withstanding the size $\varnothing 50_{-0{,}39}$. 2. Turning of surface 2 in black for length L=$96{,}5$ mm withstanding the size $\varnothing 42_{-0{,}39}$. 3. Turning of surface 3 to the length L=$74{,}5$mm withstanding the size $\varnothing 27_{-0{,}33}$. 4. Turning surface 4 to a length of 74 mm. withstanding the size $\varnothing 50_{-0{,}39}$. 5. Surface turning 5 black to a length of L=31.5 mm. withstanding the size $\varnothing 47_{-0{,}39}$.	Lathe and screw-cutting machine model 16K20P	Centre lathe chucks $GOST\ 2571-71$, Center $GOST\ 13214-79$, Machine tool rotary centres $GOST\ 8742-75$

Continuation of table 2.1

1	2	3
035 Turning and screw-cutting machine 1. Turning groove 1 with undercutting of the end according to the sketch 2. Turning of surface 2, keeping the size clean $\varnothing 45,6_{-0,16}$ 3. Chamfer turning 3 in size $1,3\times 45°$ 4. Turning chamfer 4 according to the drawing 5. Turning groove 5 according to the drawing	Lathe and screw-cutting machine model 16K20P	Thrust centrees *GOST* 13214 – 79, Machine tool rotary centres *GOST* 8742 – 75, Centre lathe chucks *GOST* 2571 – 71
6. Turning of the groove 6 with undercutting of the end according to the drawing 7. Turning of the groove 7 with undercutting of the end according to the drawing 8. Turning the groove 8 with cutting the end according to the drawing 9. Turning of the surface 9 after keeping the size cleanly $\varnothing 48,6_{-0,16}$ 10. Turning of the surface 10 after keeping the size cleanly $\varnothing 40,6_{-0,16}$ 11. Turning of the surface 11 after keeping the size cleanly $\varnothing 25,6_{-0,13}$ 12. Turning groove 12 according to the drawing 13. Turning of the surface 13 after keeping the size cleanly∅24-0.13 14. Turning sequentially chamfers 14-17, respectively, in sizes 1.6×45°, 1.3×45°, 1.3×45°, 1.3×45°		
040 Circular grinding machine 1. Preliminary grinding of the surface 1 in size $\varnothing 25,2_{-0,033}$ 2. Preliminary grinding of surface 2 to D= $40,2_{-0,039}$ 3. Preliminary grinding of surface 3 to D= $48,2_{-0,039}$	Circular grinding machine 3M131	Center *GOST* 13214 – 79, Drivers for grinding *GOST* 16488 – 70

Continuation of table 2.1

1	2	3
045 Vertical milling machine 1. Milling of keyway 1 according to the drawing	Vertical milling machine 6R11P	USP device
050 Slot milling machine 1. Milling of 6 slots with an allowance of 0.2 mm per side for grinding the sides	Semi-automatic slot milling machine 5350	Centre lathe chucks *GOST* 2571 – 71, Thrust centrees *GOST* 13214 – 79, Machine tool rotary centres *GOST* 8742 – 75
055 Circular grinding machine 1. Final grinding of surface 1 according to the drawing. 2. Final grinding of surface 2 according to the drawing 3. Final grinding of surface 3 according to the drawing 4. Final grinding of surface 4 according to the drawing	Cylindrical grinding 3M131	Drivers for grinding GOST 16488-70 Thrust centrees GOST 13214-79,
060 Turning and screw-cutting machine 1. Thread turning 1 according to the sketch	Lathe and screw-cutting machine model 16K20P	Centre lathe chucks *GOST* 2571 – 71,, Thrust centrees *GOST* 13214 – 79, Machine tool rotary centres *GOST* 8742 – 75,
065 Vertical milling machine 1. Milling of groove 1 according to the drawing	Vertical milling machine 6R11P	USP device
070 Grinding machine 1. Grinding the side surfaces of eight slots 1 according to the dimensions according to the drawing.	Grinding machine model 3451P	Centre lathe chucks *GOST* 2571 – 71, Thrust centrees *GOST* 13214 – 79, Machine tool rotary centres *GOST* 8742 – 75

Table 2.2 – Proposed shaft manufacturing route

The operation and its summary by transitions	Machine model	Technological equipment
1	2	3
005 Milling and cutting 1. Cutting a workpiece with a diameter of 55 mm and a length of 400 mm	Milling and cutting 8A631	Device at the machine
010 Heat treatment Improvements, HB 241...285	Thermal oven	
015 Lathe with CNC 1. Turning of the surface 1, 2, 3, along the outline of the part, black to size∅50-0.39;∅42-0.39;∅27-0.33; on the length respectively 315.5; 96.5; 74.5. 2. Turning groove 6; 7; 8; 12 with the end cut according to the drawing 3. Surface turning 9; 10; 11; 13, keeping the dimensions perfectly∅48.6-0.16;∅40.6-0.16;∅25.6-0.13;∅24-0.13. 4. Turning chamfers 14; 17; 16; 15 in the size of 1.3×45°. 5. Surface turning 4; 5 along the contour of the part in dimensions∅50-0.39;∅45.6-0.16. 6. Groove turning 1; 5 with the end cut according to the drawing. Chamfer turning 3; 4 in the size of 1.3×45°. 7. Thread turning 1 according to the drawing	processing center M40	Machine tool rotary centres GOST 8742-75
020 Circular grinding machine 1. Preliminary grinding of the surface 1 in size $\varnothing 25,2_{-0,033}$ 2. Preliminary grinding of the surface 2 in size $40,2_{-0,039}$ 3. Preliminary grinding of the surface 3 in size $48,2_{-0,039}$ 4. Preliminary grinding of the surface 4 in size∅45.2-0.039	Roundly-Grinding 3M131	Thrust centrees GOST 13214-79, Drivers for grinding GOST 16488-70

Continuation of table 2.2

1	2	3
025 Vertical milling machine 1. Mill keyway 1 according to the drawing	Vertical milling machine 6P11	USP device
030 Slot milling machine 1. Mill six slots 1 with an allowance of 0.1mm per side for grinding the sides	Semi-automatic slot milling machine 5350	Centre lathe chucks *GOST* 2571 – 71, Thrust centrees *GOST* 13214 – 79, Machine tool rotary centres *GOST* 8742 – 75
035 Circular grinding machine 1. Final sanding of surface 1 according to the drawing. 2. Final sanding of surface 2 according to the drawing 3. Final sanding of surface 3 according to the drawing 4. Final sanding of surface 4 according to the drawing	Roundly-Grinding 3M131	Thrust centrees GOST 13214-79, Drivers for grinding GOST 16488-70
040 Vertical milling machine 1. Mill groove 1 according to the drawing	Vertical milling machine 6P11	USP device
045 Grinding machine 1. Grind the side surfaces of eight slots 1 according to the drawing.	Grinding machine new machine model 3451	Centre lathe chucks *GOST* 2571 – 71, Thrust centrees *GOST* 13214 – 79, Machine tool rotary centres *GOST* 8742 – 75

The second option differs from the first in that operations 020; 030; 040; 050 are combined and executed on the machining center MF-60. It provides an interval feed 0.042 – 4.054 mm/rev, spindle speed 46 – 650 rev/min.

2.5 Selection of cutting, measuring and auxiliary tools

The results of choosing the design and type of measuring instrument and control tools are shown in table 2.3.

Table 2.3 – Selection of cutting and measuring tool

No operations	The name of the operation	Tool	
		Cutting	Measuring
010	Milling and cutting	Cutting cutter P6M5 GOST 2679-93	Vernier calliper ShSH–1–125–0.1 GOST 166 – 89 Bracket 8113 – 4449
020	CNC machine	Left pass-through cutter GOST 9795-73, VK6 Special cutter 9671	
025	Round grinding	Grinding wheel 2746-4002-03	Micrometer MK-51-1 GOST 6507-90 Bracket indicator 8113-4930
030	Vertical milling machine	P6M5 spline cutter GOST 9140-78	Vernier calliper ShSH–1–125–0.1 GOST 166 – 89 Template 8419-4160
035	Slot milling machine	Worm cutter for splined shafts 8x42x48 4° 3751GOST 8027-86 (2520-0282)	
040	Round grinding	Grinding wheel 2746-4002-03	Micrometer MK-51-1 GOST 6507-90 Bracket indicator 8113-4930
045	Vertical milling machine	P6M5 spline cutter GOST 32831-2014	Vernier calliper ShSH–1–125–0.1 GOST 166 – 89
050	Grinding machine	Grinding wheel 2746-4002-03	Micrometer MK-51-1 GOST 6507-90 Bracket indicator 8113-4930

2.6 Determination of machining allowances and dimensions of the shaft blank

Since the type of production is medium series, the allowances for the processing of precise surfaces are determined by the tabular method.

The results of the selection of allowances and determination of the interoperational dimensions of the part are listed in Table 2.4.

Table 2.4 – Determination of allowances by tabular method

Transitions in surface treatment	The quality of accuracy	admission mm	Allowance 2·Z, mm	The size of the workpiece	
				calculated	accepted
$\varnothing 45 js6(\pm 0.008)$					
Preparation				$\varnothing 50$	
Rough turning	13	0,39	8	$\varnothing 47$	$\varnothing 47_{-0,39}$
The turning is clean	11	0,16	1,4	$\varnothing 45,6$	$\varnothing 45,6_{-0,16}$
Preliminary grinding	8	0,039	0,4	$\varnothing 45,2$	$\varnothing 45,2_{-0,039}$
Grinding is final	6	0,016	0,2	$\varnothing 45$	$\varnothing 45 js6(\pm 0.008)$
$\varnothing 40 js6(\pm 0.008)$					
Preparation				$\varnothing 50$	
Rough turning	13	0,39	8	$\varnothing 42$	$\varnothing 42_{-0,39}$
The turning is clean	11	0,16	1,4	$\varnothing 40,6$	$\varnothing 40,6_{-0,16}$
Preliminary grinding	8	0,039	0,4	$\varnothing 40,2$	$\varnothing 40,2_{-0,039}$
Grinding is final	6	0,016	0,2	$\varnothing 40$	$\varnothing 40 js6(\pm 0.008)$
$\varnothing 48h6(_{-0,016})$					
Preparation				$\varnothing 55$	
Rough turning	13	0,39	5	$\varnothing 50$	$\varnothing 50_{-0,39}$
The turning is clean	11	0,16	1,4	$\varnothing 48,6$	$\varnothing 48,6_{-0,16}$
Preliminary grinding	8	0,039	0,4	$\varnothing 48,2$	$\varnothing 48,2_{-0,039}$
Grinding is final	6	0,016	0,2	$\varnothing 48$	$\varnothing 48h6(_{-0,016})$
$\varnothing 25 p6(^{+0,035}_{+0.022})$					
Preparation				$\varnothing 42$	
Rough turning	13	0,33	15	$\varnothing 27$	$\varnothing 27_{-0,33}$
The turning is clean	11	0,13	1,4	$\varnothing 25,6$	$\varnothing 25,6_{-0,13}$
Preliminary grinding	8	0,033	0,4	$\varnothing 25,2$	$\varnothing 25,2_{-0,033}$
Grinding is final	6	0,013	0,2	$\varnothing 25$	$\varnothing 25 p6(^{+0,035}_{+0.022})$

2.7 Dimensional analysis of the shaft manufacturing process

Since the specifics of the process route are such that none of the final dimensions are automatically obtained, it does not make sense to perform dimensional analysis calculations.

2.8 Determination of shaft processing modes and technical time standards

Cutting modes are calculated by two methods: analytical and tabular [18, 19].

For example, the calculation of cutting modes will be detailed for operation 030.

Operation 030– Vertical milling machine

In this operation, milling of the keyway is performed. The equipment is a vertical milling machine of the 6P11P model.

The cutting tool is a key cutter with a cylindrical shank according to GOST 9140-78, the material of the cutting part of the cutter is P6M5 steel, the diameter of the cutter D =6mm.

The device is with manual clamping, assembled from the USP kit.

The control tool is a caliper ShC-II-0.05 GOST 166-89.

We determine cutting modes analytically according to the reference book [4].

1) Depth t and width B milling: *t*= 3.5 mm, *B*= 6 mm.

2) Durability of the milling cutter, T = 80 min.

3) There is a calculated feed per tooth of the milling cutter

- vertical (when cutting to the depth of the keyway) Szв=6x10-3 mm/tooth;
- longitudinal (when milling to the length of the keyway) Szp=2*10-2 mm/tooth.

4) We determine the calculated circular speed of rotation of the milling cutter:

$$V_p = \frac{C_v \cdot D^q}{T^m \cdot t^x \cdot S_z^{\ y} \cdot B^u \cdot Z^p} \cdot K_v \ , \qquad (2.8)$$

Where $C_v = 12;\ q = 0,3;\ m = 0,26;\ x = 0,3;\ y = 0,25;\ u = 0;\ p = 0$;

$K_v = K_{nv} K_{iv}\ K_{mv}$ *for* K_{nv} = 1.0; K_{iv} = 1.0;

$$К_{MV} = К_{Г} \cdot \left(\frac{750}{\sigma_{в}}\right)^{n_V}, \tag{2.9}$$

where Kg= 1; n_v = 0.90.

$$К_{MV} = 1 \cdot \left(\frac{750}{750}\right)^{0,9} = 1$$

$K_V = 1 \cdot 1 \cdot 1 = 1$

So

$$V_p = \frac{12 \cdot 6^{0,3}}{80^{0,26} \cdot 3{,}5^{0,3} \cdot 0{,}02^{0,25} \cdot 6^{0} \cdot 2^{0}} \cdot 1 = 12 \text{ m/min}$$

5) We determine the estimated spindle rotation frequency:

$$n_p = \frac{1000 \cdot V_p}{3{,}14 \cdot D}, \tag{2.10}$$

where D is the cutter diameter, D=6.0 mm.

We will get by substituting the value:

$$n_p = \frac{1000 \cdot 12}{3{,}14 \cdot 6} = 637 \text{ rpm}$$

We accept according to the passport of the machine n_p = 630 rpm.

6) We determine the actual cutting speed:

$$V_д = \frac{3{,}14 \cdot D \cdot n_д}{1000}, \tag{2.11}$$

$$V_д = \frac{3{,}14 \cdot 6 \cdot 630}{1000} = 11{,}9 \text{ rpm}$$

7) We determine the calculated vertical S_{hvv} and longitudinal S_{hvp} minute feeds of the table:

$S_{hvv} = S_{zв} \; Z \; n_д \; = \; 0{,}0066302 \; = \; 7{,}56$ mm/min

$S_{hvvp} = S_{zп} \; Z \; n_д \; = \; 0{,}026302 \; = 25{,}2$ mm/min

We specify according to the passport of the machine: S_{hvvd} =8.30 mm/min; S_{hvvp} =25.0 mm/min.

8) We determine the actual value of the longitudinal feed per tooth using the formula:

$$S_{znn} = \frac{S_{xвnд}}{Z \cdot n_{д}} = \frac{25}{2 \cdot 630} = 0{,}02 \text{ mm/tooth}$$

9) We determine the main component of the cutting force:

$$P_z = \frac{10 \cdot C_P \cdot t^X \cdot S_{znn}{}^Y \cdot B^u \cdot Z}{D^q \cdot n_{д}^w} \cdot K_{mp}, \qquad (2.12)$$

Where $C_p = 68{,}2,\ x = 0{,}86,\ y = 0{,}86,\ u = 0{,}72,\ q = 0{,}86,\ w = 0$;

$$K_{мр} = \left(\frac{\sigma_в}{750}\right)^{0,3} = \left(\frac{750}{750}\right)^{0,3} = 1$$

$$P_z = \frac{9.81 \cdot 68.2 \cdot 3{,}5^{0.86} \cdot 0{,}02^{0.72} \cdot 6^1 \cdot 2}{6^{0.86} \cdot 630^0} \cdot 1 = 192\,H$$

10) Power spent on cutting:

$$N_{різ} = \frac{P_z \cdot V_д}{1020 \cdot 60} = \frac{258 \cdot 11{,}9}{1020 \cdot 60} = 0{,}04 \text{kW}$$

11) We check whether the drive power of the machine is sufficient:

the cutting condition is as follows

$$Cut < N_d * \eta$$

where N_d - machine engine power N_d = 5.50 kW;

η - coefficient of performance, η= 0.80.

Thus, 0.04 kW < 5.5·0.8 = 4.4 kW. The condition is fulfilled.

12) We determine the main time:

$$T_o = \frac{t_1 + l_1}{S_{xвeд}} + \frac{l - D}{S_{xвnд}}, \qquad (2.13)$$

where l1 is the length of the milling cutter, l1 = 1.5 mm;

l- the length of the keyway, l = 30.0 mm;

Then

$$T_o = \frac{3,5+1}{8,3} + \frac{32-6}{25} = 1,58 \text{ min}$$

We define the cutting modes for the rest of the part manufacturing operations similarly, and only the results are entered in Table 2.5.

Table 2.5 – Summary table of cutting modes for shaft manufacturing

number of operations and transitions	D, mm	L_{rx}, mm	t, mm	and	S, mm/rev	V, m/min	n, rpm	So, min
010								
1	710	58	3	1	25	21,4	9,6	2,32
015								
1	55	316	4	2	0,3	108,8	630	1,82
2	55	5	4	2	0,05	138,2	800	0,33
3	50	316	0,8	1	0,1	135,6	1000	1,47
4	48,6	2	1,3	1	0,05	122,1	800	0,16
5	55	76	2,5	1	0,3	108,8	630	0,57
6	45,6	2	1,3	2	0,05	130,2	800	0,17
7	24	23	-	3	1,5	4,7	63	1,46
020								
1	600/25	25	0,2	-	4000/0,004	34,9/15,7	1112/200	0,69
2	600/40	0,2	-	-	0,4 mm/min	34,9/25,1	1112/200	0,55
3	600/48	195	0,2	-	4000/0,004	34,9/30,1	1112/200	5,36
4	600/45	0,2	-	-	0,4 мм/хв	34,9/28,3	1112/200	0,55
025								
1	6	4,5/24	3,5	1	8,3/25	11,9	630	1,58
030								
1	90	240	3	-	2	28,3	100	9,6
035								
1	600/25	25	0,2	-	4000/0,003	34,9/15,7	1112/200	0,58
2	600/40	0,1	-	-	0,3 mm/min	34,9/25,1	1112/200	0,47
3	600/48	195	0,2	-	4000/0,003	34,9/30,1	1112/200	4,55
4	600/45	0,1	-	-	0,3 mm/min	34,9/28,3	1112/200	0,47
040								
1	6	20	2	1	25	11,9	630	0,8
045								
1	-	180	0,1	-	0,01	4	4430	5,4

We will do it calculation of time norms for operation 025.

Operation 040- Vertical milling machine

We perform calculations according to standards [13] in the following sequence.

1) The main time for the operation T_o = 1.59 min.

2) Auxiliary time for the operation:

$$T_d = (T_{vst} + T_{per}) \cdot K \ , \tag{2.14}$$

where T_{vst} is the time for installing and removing the part. When installing a part weighing up to 3 kg on prisms with nut and bar fastening without calibration T*vst* = 1.20 min.

Now- the time associated with the transition, when processing with a milling cutter, which is set to the size of the limb without measurement, the length of the surface up to 100 mm, T_{per} = 0.40 min. (pos. 2, map 54, sheet 1).

K- a correction factor that takes into account the size of the lot of parts, if the number of parts in the lot is more than 15 pieces. and operating time up to 3 minutes. *K*=1.1;

So

$$T_d = (1,2 + 0,4) \cdot 1 = 1,6 \,\text{min}$$

3) Operational time:

$$T_{op} = T_o + T_d = 1,58 + 1,6 = 3,18\,\textit{хв}$$

4) Time for workplace maintenance:

$$T_{obc} = \frac{T_{op} \cdot A_{obc}}{100} \ , \tag{2.15}$$

where A_{obs} is the time for servicing the workplace as a percentage of operational time, A_{obs} = 4%.

$$T_{obc} = \frac{3,18 \cdot 4}{100} = 0,13 \,\text{min}$$

5) Time for rest and personal needs:

$$T_{vop} = \frac{T_{op} \cdot A_{vop}}{100} \ , \tag{2.16}$$

where A_{vop} - time for rest and personal needs as a percentage of operative time, A_{vop}=4%.

$$T_{vop} = \frac{3{,}18 \cdot 4}{100} = 0{,}13\,\text{min}$$

6) Artificial time for operation:

$$T_{\text{sht}} = T_{on} + T_{vop} + T_{obc} = 3{,}18 + 0{,}13 + 0{,}13 = 3{,}44 \ \text{min}$$

7) Preparatory and final time: when processing in the device with its replacement and the simple complexity of preparation for work T_{pz} = 16.0 min.

8) Artificial calculation time for the operation:

$$T_{\text{sht.}\kappa} = T_{\text{sht}} + \frac{T_{pz}}{n} = 3{,}44 + \frac{16}{12} = 4{,}77 \ \text{min}$$

where n is the number of parts in the batch, we take n = 12 pieces.

We perform similar calculations for other mechanical operations, manufacturing the part, and enter the results in Table 2.6.

Table 2.6 – Labor intensity of manufacturing the shaft

No. of operation and its name	T_0, min	T_d, min	K_d	T_d, min	T_{op}, min	T_{obs}		T_{wp}		T_{sht} min	T_{pz}, min	$T_{sht.k}$, min
						%	min	%	min			
005 Milling and cutting.	2,32	1,1	1	1,1	3,42	6	0,21	4	0,14	3,8	14	4,94
015 Lathe with CNC	5,98	5,84	1	5,84	11,5	6	0,4	4	0,4	12,6	32	15,4
020 Circular grinding machine	7,15	1,36	1	1,36	8,51	8	0,68	4	0,34	9,53	10	10,36
025 Vertical milling machine.	1,58	1,6	1	1,6	3,18	4	0,13	4	0,13	3,44	16	4,77
	9,60	0,57	1	0,57	10,17	4	0,41	4	0,41	11,1	23	12,91
030 Slot milling machine	6,07	1,36	1	1,36	7,43	8	0,59	4	0,30	8,32	10	9,15
035 Circular grinding machine	0,80	1,6	0,9	1,68	2,48	4	0,10	4	0,10	2,68	16	4,01
040 Vertical milling machine.	5,40	0,86	1	0,86	6,26	10	0,63	4	0,25	7,14	26	9,31
045 Grinding machine												
In total	38.9											70.85

3 DESIGN PART

3.1 Device for milling the keyway of the shaft

The device is designed for milling a keyway on a 6P11 vertical milling machine. In the design of the device, we use only parts from the set of universally assembled devices (UFD), taking into account that the type of production, according to the task, is medium-series.

For each operation, we assemble a special-purpose device from pre-prepared elements (parts and non-disassembleable assembly units), and after use, we disassemble it. Parts and assembly units of UFD are constantly in circulation in production.

The main advantages of using the UFD system are:

1) use in such technological operations where the use of special devices is unprofitable;

2) a significant reduction in the labor intensity and cost of production of technological equipment during the transition to the production of a new machine, since the assembly of UFD is carried out by fitters directly in the production workshops according to the working drawing of the part or according to its experimental sample;

3) significant saving of metal due to multiple use of UFD parts and assembly units.

UFD parts and assembly units, depending on the width of the T- and U-shaped grooves, are divided into three series (2 - 4) with a groove width of 8 (UFD-8), 12 (UFD-12), 16 (UFD-16) millimeters, respectively. For medium mechanical engineering, the UFD-12 kit is recommended.

The device is intended for fixing the workpiece of milling a keyway.

The general appearance of the device is shown in the graphic part of the project.

The detail is placed in prisms. To clamp the part, compressed air is supplied through the hole above the piston 8 into the upper cavity of the cylinder 25. Under the action of the compressed air, the piston 8 goes down and will pull the levers 9 with it, which will turn the rollers 10 and the levers 24 connected to the fists 16 and prisms 12, 19. The prisms, moving in the grooves of the housing 1, clamp the part. To unfasten the part, it is necessary to supply compressed air through the sleeve 26 into the lower cavity of the cylinder 25 (under the piston 8).

We determine the clamping force of the part in the device by solving the problem of statics. Let's make a calculation scheme (Fig. 3.1).

At the same time, we determine the clamping force by the formula:

$$Q = \frac{kM}{f_1 R + f_2 R / Sin(\alpha/2)}; \tag{3.1}$$

where k is the reserve factor, k = 2.55;

M –torque that occurs during the drilling process;

f_1 i f_2 – coefficients of friction between the supporting surfaces, the part and the clamping elements of the technological device, f_1 = f_2 = 0.16;

α – prism angle, α=90°.

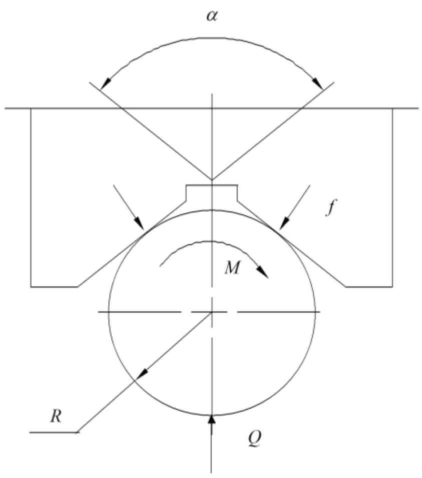

Figure 3.1 – Calculation scheme of the device

We determine the moment that occurs during milling

$$M = C_M D^g S^y k_\rho; \tag{3.2}$$

where C_M = 3,5*10^{-2}; g = 2.1; y = 0.85; k_ρ =0.815.

$M = 0.0355´22.1´0.2240.85´0.815 = 0.892$ kg / m.

$$Q = \frac{2.6 \cdot 0.89}{0.15 \cdot 0.015 + \dfrac{0.15 \cdot 0.015}{Sin45°}} = 4470\, H.$$

Diameter D of the working pneumatic cylinder:

$$W = \frac{\pi}{16} \cdot \left(D + d^2\right)\rho;$$

Звідки $\quad \left(D + d\right)^2 = \sqrt{\frac{16 \cdot W}{\pi \cdot \rho}} = \sqrt{\frac{16 \cdot 447}{3.14 \cdot 6}} = 19.5. \quad (3.3)$

Therefore, the diameter of the membrane: D = 46.0 mm.

3.2 Development of the design of a chuck with a mechanized drive for a lathe

The three-jaw lathe chuck with a mechanized drive is designed for shaft processing on the MF-60 model machining center.

The cartridge is placed on the flanged end of the machine spindle. It consists of a body, in the radial grooves of which three cams are moved, with the grooved surface of which replaceable pads are coupled. The screws are used to fasten the pads to the cams. During the axial movement of the clutch under the action of the pneumatic drive, the cams receive a radial movement and clamp or release the part.

We must determine the amount of axial force applied to rod 13 in order to ensure that the required clamping force is obtained.

We perform calculations based on the calculation scheme (Figure 3.2).

We determine the required drive effort

$$Q = n \cdot K^{/} \cdot \left(1 + \frac{3l}{l_1} f_1\right) \cdot tg\left(\beta + \phi\right) \cdot W, \quad (3.4)$$

where n is the number of cams;

K – reserve ratio;

β – wedge angle in degrees;

l_1 – length of the guide part of the cam, mm;

K·– coefficient that takes into account additional frictional forces in the cartridge;

F – coefficient of friction on the working surfaces of the cams;

l– displacement of the cam from the support to the center of application of the clamping force, mm;

φ – angle of friction on the inclined surface of the wedge in degrees;

W – required clamping force on each cam.

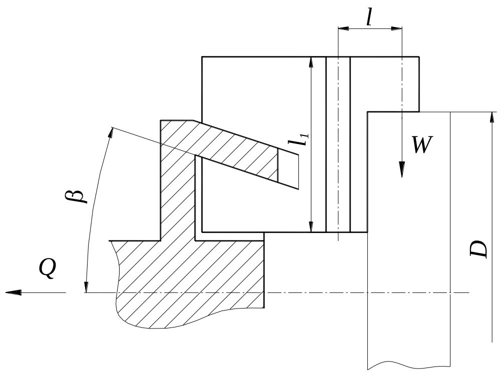

Figure 3.2 – Calculation diagram of forces during turning in a three-jaw chuck

Clamping force on each cam:

$$W = K \cdot P_z \cdot \frac{\sin\frac{\alpha}{2}}{n \cdot f} \cdot \frac{D_1}{D}, \tag{3.5}$$

where P_z is the circular cutting force;

α– cam prism angle;

D_1– diameter of the treated surface, mm;

$D$is the diameter of the clamped surface.

$$W = 1.5 \cdot 200 \cdot \frac{1}{3 \cdot 0.25} \cdot 0.75 = 300\ N.$$

$$Q = 3 \cdot 1.05 \cdot (1 + 0.7 \cdot 0.15) \cdot tg\,(7°7'30'' + 5°43') \cdot 300 = 200.8\ N\ .$$

Such an axial force can be created by a pneumatic cylinder according to GOST 46683-71 at a system pressure of 6 atmospheres. In this way, the processing of the part on the machining center of the MF-60 model using the developed chuck is possible.

3.3 Device for controlling end and radial runout of shaft surfaces

The design of the device is designed to control the radial and end runout of the shaft 47.628.007.

The device consists of a frame to which two brackets are attached using bolts. We can change the position of the brackets relative to the longitudinal axis of the frame. The centers are fixed in the brackets - the left one is smooth and fixed, the right one is also smooth, but spring-loaded with the possibility of fixation in a given position for fixing the part.

A stand for installing a clock-type measuring indicator is also attached to the frame.

The shaft is installed in the centers for its control. Next, we bring the measuring head into contact with the part and fix it in this position. After that, we set the indicator scale to "0".

To measure the radial runout, we rotate the part around the longitudinal axis and determine the amount of runout based on the deflection of the indicator arrow. It should be no more than 0,020 mm.

3.4 Calculation of the grip of an industrial robot

We choose a wide-range clamping device with a rack-and-pinion transmission mechanism.

The assembly drawing of the manipulator of the industrial robot is given in the graphic part of the project.

The calculation for the selected device is as follows. We will determine the forces acting in the places of the workpiece and jaws.

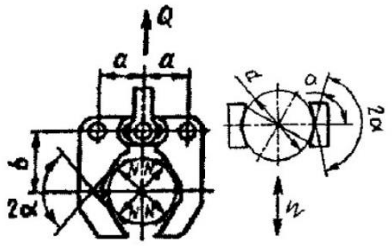

Figure 3.2 – Calculation diagram of industrial robot grip

Clamping force:

$$Q = 1{,}3P\left(\frac{W}{g}+1\right)\left(0{,}63\frac{b}{a}+\frac{1{,}5ab}{(b+0{,}1d)a}\right)k, \qquad (3.6)$$

where g = 9,81 m/s^2;

P = *mg* =0.510*9,81 = 5.1 N;

a, b, a1, b1 - constructive grip dimensions, m;

W– acceleration that occurs during the movement of the gripper, m/s2;

k= 1.75 – reserve ratio;

d– workpiece diameter, m.

$$Q = 1{,}3*5\left(\frac{4}{9{,}81}+1\right)\left(0{,}63\frac{0{,}043}{0{,}021}+\frac{1{,}5*0{,}01*0{,}043}{(0{,}016+0{,}1*0{,}026)0{,}021}\right)1{,}75 = 45{,}85\text{H}$$

We determine the magnitude of the force acting at the points of contact between the workpiece and the clamping jaws

$$N = Q\frac{a}{4b\sin\frac{a}{2}k}, \qquad (3.7)$$

where α = 70° is the angle of the prismatic depression of the jaws;

k=1.75 – reserve factor.

$$N = 45{,}8\frac{0{,}021}{4*0{,}043\sin70*1{,}75} = 3{,}5\ \text{кг}$$

We determine the estimated stresses at the point of contact between the part and the gripping device:

$$\sigma = 0{,}836\sqrt{\frac{N}{l} * \frac{EzEg}{d(Ez+Eg)}}, \tag{3.7}$$

where Ez, Eg - modulus of elasticity of the workpiece material, Ez = Eg = $2.1 \cdot 10^6$;

lz- thickness of the capture lever, mm;

$$\sigma = 0{,}836\sqrt{\frac{3500}{0{,}012} * \frac{2{,}1 * 10^6 * 2{,}1 * 10^6}{0{,}026(2{,}1 * 10^6 + 2{,}1 * 10^6)}} = 287{,}25 \text{ Па}$$

The operating condition of the device is $[\sigma_d] > \sigma$, where $[\sigma_d]$ = 510 Pa. Therefore, we chose the correct design of such equipment. It allows you to grasp the part without damaging its surface.

4 LIFE SAFETY AND FUNDAMENTALS OF LABOR PROTECTION

4.1. Analysis of harmful production factors at the site and measures to eliminate them.

The main harmful factors on the site are:

1. Production noise of machine tools, which weakens the attention of workers. The source of manufacturing noise is mainly technological and production equipment, vehicles, etc. Increased noise from working equipment, vehicles, as a rule, is the result of disturbing the centering of individual units of mechanisms, the lack of lubrication in bearings, gears, and the like. Carrying out repair work is accompanied by additional noise. Its value should not exceed the maximum permissible standards, regulated by safety requirements.

2. Production vibration. Under vibration usually refers to mechanical vibrations of elastic bodies with a frequency exceeding 1Hz. The sources of vibration in production are separate unbalanced nodes and parts of equipment, mechanized tools, etc. Typically, exceeding the permissible level of vibration is the result of a structural failure of the equipment or the loss of technical characteristics of the interaction of individual units of equipment due to the untimely conduct of its inspection and repair.

3. Air pollution. Some technical processes are accompanied by the release of harmful substances into the working environment air. The working area is considered to be a space up to 2 m high above the floor level or the place where the permanent or temporary working places are located. The concentration of harmful substances in the working area must not exceed the maximum permissible concentrations established by the normative documents.

4. Fugacity of the air of treated materials. The greatest dustiness is characteristic for those kinds of technological operations, where loading, unloading, crushing, sifting and mixing of various materials, which produce fine particles, takes place. All types of industrial dust are aerosols, in which the dispersed medium is air, and the dispersed phase is solid dust particles of at least 5 microns. Stubbing in the breathing zone of machine tool operators must meet the maximum permissible standards.

5. ZOR. As a result of the evaporation of the ZOR, contamination of the respiratory zone of machine operators, their clothes and open parts of the case occurs. This is the cause

of the specific diseases of the workers. ZOR may also exhibit an irritant effect on the mucous membranes of the upper respiratory tract.

6. Insufficient artificial lighting of the working area. This leads to over-strain of the worker's vision and makes him approach the treatment zone, which is associated with the danger of injury. In accordance with the applicable norms for feeding lamps of local lighting with incandescent lamps, the voltage should not exceed 24 V.

7. Temperature and relative humidity of the working zone air.

Meteorological conditions in industrial premises are mainly determined by the temperature and relative humidity of the air in the working area. In order for the physiological processes in the human case to flow normally, the case should be exposed to heat in the environment. The correspondence between the amount of this heat and the cooling capacity of the environment characterizes it as comfortable. In conditions of comfort, the worker does not have to worry about his thermal sensations - cold or overheating. Thus, in a production environment for a worker's thermal health it is important to have a certain combination of temperature and relative humidity of the air in the working zone.

4. 2 Microclimate of the production room

Clean air of the required chemical composition, optimum temperature, humidity and speed of its movement is essential for the normal functioning of the worker. Creation in the working zone of metal-cutting machines of the necessary meteorological conditions has a good effect on an organism, promotes well-being, considerably increases the safety of work, provides a high degree of working capacity.

Therefore, meteorological conditions in the working areas of machine tools must meet regulatory requirements. As for the air temperature, it should be: in the cold period of the year - 18 - 200; in the warm period of the year - 21 -230. Regarding the relative humidity, regardless of the period of the year, its value should not exceed 75%. Exceeding the relative humidity relative to the established norms has a negative impact on the health of workers. Regarding the speed of air movement: it should be in the range of 0.2 - 0.3 m / s. Exceeding or reducing the speed of air movement in accordance with the established norms also has a negative impact on the health of workers. In accordance with regulations, the values of temperature,

The category of work is the distribution of work based on the total energy expenditure of the body, which is measured in joules per second. For our case, the given normative values correspond to the average severity of the category of works. Regarding the thermal regime, depending on it, there are rooms with insignificant and significant excesses of obvious heat. Explicit heat means heat that enters the room from equipment, heaters, heated materials and other sources, which affects the temperature in the room. So, in our case, according to [2], a room with a slight excess of heat is used, for which the above normative values are set.

4.3 Characteristics of natural disasters, accidents (catastrophes) and their consequences

Natural disasters - a natural phenomenon (earthquake, flood, avalanches, hurricanes, cyclones, typhoons, fires, volcanic eruptions and others), which are extraordinary and which lead to disruption of normal population, death, destruction and destruction of property.

Natural disasters can occur both independently of each other and in a relationship: one of them can lead to another. Some of them often arise as a result of not always reasonable activity (forest and peat fires, industrial explosions in mountainous areas, etc.).

Regardless of the source, natural disasters are characterized by significant scales and varying lengths - from a few seconds and minutes (earthquakes, avalanches) to several hours, days (landslides) and months (floods).

Earthquakes are strong vibrations of the earth's crust that are caused by tectonic or volcanic causes and that lead to the destruction of buildings, premises, fires and human losses.

The main characteristics are: depth of fire, magnitude and intensity of energy on the earth's surface.

The depth of an earthquake fire is usually in the range of 10 to 30 km, in some cases it can be much greater.

Earthquakes cause other natural disasters, such as landslides, avalanches, tsunamis, floods (due to breakthroughs of rafts), fires (damage to oil storage and rupture of gas pipelines), damage to communications, power lines, water supply and sewerage, chemical accidents. productions with leakage (spill) SDOR, and also on automatic telephone exchanges with leakage (emission) of mercury substances in the atmosphere and others.

To protect against earthquakes, seismically dangerous zones are detected in different regions, so-called seismic zoning is carried out. Such zones provide for various measures of protection, from compliance with the requirements and rules for the construction and reconstruction of buildings and other facilities to the suspension of hazardous industries (chemical plants, automatic telephone exchanges, etc.).

Floods are significant flooded areas as a result of rising water levels in rivers, lakes, reservoirs, which are caused by various reasons (precipitation, dam collapses, etc.). Floods cause great material damage and lead to human casualties.

Immediate material damage from floods is damage to and destruction of houses, highways, power lines, damage to agricultural land, etc.

Floods can be accompanied by fires due to breaks and short circuits of electrical cables and wires, as well as ruptures of water and sewer pipes, electrical, television and telegraph cables that are in the ground, due to subsequent uneven soil precipitation.

The main directions of flood control are to reduce the maximum flow of water in the river by redistribution of runoff (planting of forest protection strips, orc of land across the slopes, etc.).

In addition, to protect against floods widely used method -dam. To eliminate dangerous formations of congestion are directed, clearing and deepening of certain sections of the riverbed, as well as the destruction of ice by explosions.

Nuthatches are a sliding mixture of rocks down the slope, which occurs due to imbalance, which is caused by various reasons (washing the rock with water, weakening their strength due to precipitation, systematic shocks, unreasonable agricultural activities, etc.).

Nuthatches can be on all slopes with a slope of 20º or more at any time of the year. They differ not only in the speed of displacement of the rock (slow, medium and fast), but also in their scale. The speed of slow displacements of the rock is several tens of centimeters per year, medium - a few meters per hour or per day and fast - tens of kilometers per hour or more.

Rapid displacements include creeping streams, when solid material mixes with water, as well as snow and snow avalanches. It should be emphasized that only rapid landslides can cause catastrophes with human losses.

Nuthatches can destroy settlements, destroy agricultural land, be dangerous in the operation of quarries and mining, damage communications, tunnels, pipelines, telephone and electrical networks, dams.

The most effective protection against crawlers is to prevent them. From a complex of preventive actions it is necessary to note collecting and removal of surface waters, artificial transformation of a relief (in a zone of possible separation of the earth to reduce loadings on slopes), fixing of a slope by means of building basic walls.

Avalanches are creeps and occur as well as other displacements. The forces of adhesion of snow exceed a certain limit, and gravity causes the displacement of snow masses on the slope. An avalanche is a mixture of snow crystals and air. Dimensional avalanches occur on slopes of 25º-60 °. Smooth grassy slopes are the most avalanche-prone. Bushes, large rocks and other obstacles hold back the avalanches that have occurred. Avalanches are very rare in the forest.

Avalanches cause material damage and are accompanied by death. Avalanche protection can be passive and active. With passive protection, avoid the use of avalanche-prone slopes or place barrier shields on them. With active protection, avalanche-prone slopes are shelled, causing the displacement of small dangerous avalanches, thus preventing the accumulation of critical masses of snow.

Storms are winds with a force of 12 points on the Beaufort scale, ie winds whose speed exceeds 32.6 m / s (117.3 km / h).

Storms are also called tropical cyclones, which occur in the Pacific Ocean off the coast of Central America; in the Far East and in the Indian Ocean storms are called typhoons. During tropical cyclones, wind speeds often reach 50 m/s. Cyclones and typhoons are usually accompanied by heavy torrential rains.

Storms on land destroy buildings, communication lines and power lines, damage communications and bridges, break and uproot trees; when propagating over the sea, they cause large waves 10-12 m or higher, damage or even destroy ships.

Storms and stormy winds (their speed on the Beaufort scale from 20.8 to 32.6 m / s) in winter can lift large masses of snow into the air and cause snowstorms, which leads to blizzards, traffic and rail traffic, disruption of water systems -, gas -, power supply and communication.

Modern methods of weather forecasting allow to warn the population about the approach of storms (storms) in a few hours and even days, and the Central Election Commission can provide the necessary information about the possible situation and necessary actions in situations that have arisen.

The most reliable protection of the population from storms is the use of protective buildings (metro, storage, underground passages, basements, etc.). at the same time it is necessary to consider possible flooding of sites and to choose protective storages on the raised sites of the district.

CONCLUSIONS

1. Improved manufacturing processshaft47.628.007 was developed. He is characterized by improved technical and economic indicators (coefficient concentration of processing, reduction of costs for equipping the production process, reduced preparatory and final time in operations, improved working conditions of production workers). For this, the type of production was determined and the manufacturability analysis of the part was carried out, the method of obtaining the workpiece was chosen and its main dimensions were calculated, the design of the sequences of processing the surfaces of the workpiece and the operational technological process of manufacturing the part was carried out. On the basis of the operational technological process of manufacturing the part, the selection of the machine tool was made, and the cutting modes were determined. To improve the machine tool, calculations and design of the machine tool for fixing the part in the technological operation of mechanical processing were carried out, the machine tool was improved.
2. Measures for labor protection and life safety have been developed

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