Ministry of Education and Science of Ukraine
Ternopil Ivan Puluj National Technical University

Faculty of Engineering of Machines, Structures and Technologies
(full name of faculty)
Engineering Technology
(full name of department)

QUALIFYING PAPER

For the degree of

master
(degree name)

topic: Development of the body structure BL 8.013.016 production process and the study of kinematic parameters of flat polishing

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Ternopil
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Ministry of Education and Science of Ukraine
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ASSIGNMENT
for QUALIFYING PAPER

for the degree of master
(degree name)

specialty 131 Applied mechanics
(code and name of the specialty)

student Kannadhasan Avinash
(surname, name, patronymic)

1. Paper topic Development of the body structure BL 8.013.016 production process and the study of kinematic parameters of flat polishing

Paper supervisor Professor Maruschak P.O.
(surname, name, patronymic, scientific degree, academic rank)

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2. Student's paper submission deadline __________

3. Initial data for the paper 1. Basic TP manufacturing parts. 2. The program is 1080 pieces/ year. 3. Drawing the body part.

4. Paper contents (list of issues to be developed)
1. Analytical part, 2 Research part, 3.Technological part, 4.Safety measures.

5. List of graphic material (with exact number of required drawings, slides)
Technological cards adjustments, assembly drawings of devices, drawing of the control device.

6. Advisors of paper chapters

Chapter	Advisor’s surname, initials and position	Signature, date	
		assignment was given by	assignment was received by
Safety measures	Professor Baranovskyi V.M.		

7. Date of receiving the assignment *29 March 2021*

TIME SCHEDULE

LN	Paper stages	Paper stages deadlines	Notes
1	*Analytical part,*	1.04.2021	
2	*Research part*	15.04.2021	
3	*Technological part*	1.05. 2021	
4	*Safety measures*	1.06.2021	
5	*Drawings*	15.06.2021	

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Paper supervisor ______ (signature) Maruschak P.O. (surname and initials)

CONTENT

ABSTRACT

The site of the mechanical shop for the processing of parts of the type "case" with a detailed development of the technical process of manufacturing the housing BL 8.013.016.

Number of pictures -

Number of tables -

In the thesis the analysis of the technical conditions and the technical process of manufacturing the part of the "case" is made.

Route-operational technological process of manufacturing parts has been developed.

Technological design calculations are carried out. Drawings of easel and control tools were designed. Drawings of technological debugging, equipment planning on the worksite area are executed.

The type of production and the organizational form of the production of parts are selected, cutting regimes are calculated, technological standards of time.

In accordance with the task, developed work on the protection of labor and economics.

INTRODUCTION

The modern level of technical progress, the continuous creation of new perfect high-performance, automated and high-precision machines, based on the use of the latest advances in science, require the engineer of high theoretical training, as well as possession of new technology and production technology.

Machines serve to increase productivity, and this is now the most important. In addition, advanced engineering is the basis of technical and economic independence and defense of the country.

The production of machines is continuously developing. There is no single branch of the national economy, where different kinds of machines are not used. The work of many people who invest in the production of machines is rationally used only if it is directed by a clearly well-designed technology.

Therefore, the technologist who takes part in the development of the technological process of manufacturing is responsible to the factory for the construction of the technological process, which ultimately is a program of human resource resources.

Developing the technological process of manufacturing machines requires a creative approach. Only on the basis of creativity can you ensure the coherence of all stages of the construction of the machine and achieve the required quality with the lowest cost of labor.

1 ANALYTICAL PART

1.1 Analysis of flat surface treatment schemes

In the analysis of existing processing methods and the choice of device designs, special attention was paid to the feasibility of their use for processing large flat surfaces.

Existing processing schemes in most cases involve a horizontal installation, however, a vertical layout is used. However, for the conditions of repair production of large parts, it is unacceptable because it has a complex installation of parts and difficult maintenance of the technological process. The analysis of the existing schemes of processing is expedient to carry out on the following classification signs:

- location of the part (horizontal and vertical processing scheme);
- method of longitudinal feed axial movement of the circle, tangential displacement of the circle.

Flat surfaces in the main production are processed on special machines equipped with grinding wheels of large diameter and having a high-power drive. This is the main obstacle to the application of this scheme in repair production. Reducing the dimensions of the grinding device can be achieved by machining the end face of the grinding wheel.

There is a device for grinding the end face of a circle of cylindrical surfaces with an individual drive from an electric motor which is installed on the caliper of a lathe. The device is used in the processing of rod-type parts with a cup diamond wheel which is brought to the workpiece surface and moved along the axis of the part. Different directions of roughness lines are obtained by changing the position of the grinding wheel relative to the axis of rotation of the part. The described grinding scheme was investigated in relation to finishing methods of processing and did not consider the question of geometric accuracy and the possibility of processing cylindrical surfaces bounded by flanges. The complexity of the configuration of the crankshaft imposes additional requirements for the layout of the grinding device and its binding to the equipment. There are three possible options. In one embodiment, the grinding device must provide processing of the fixed part and the circular feed must be provided by the design of this device. In this case, the grinding head is made in the form of clamps covering the neck, carrying a grinding wheel. Collars (housing) must be detachable with precisely made end and ring directions. The device is rotated by a pneumatic or hydraulic drive through a gear. A necessary condition for reliable operation of this type of device is to ensure high precision manufacturing of the guide elements, the density of the joints and lubrication of moving parts. These shortcomings limit their use in repair conditions. Schemes with rotation of a detail around an axis of a radical or connecting rod neck are much more perspective.

Machining with rotation of the part around the axis of the connecting rod neck greatly simplifies the design of grinding devices and the scheme of their basing, but processing can be carried out only in the presence of centrifuges, which are installed on large diameter shafts with connecting rod necks in different planes. Even a small error in the installation of the center displacements can lead to errors in the relative position of the axes of the connecting rod necks.

When rotating the part around the axis of the root neck, two schemes of basing of the grinding device are possible:

1. Installation of a grinding device on a tracking system consisting of two eccentric parts that rotate synchronously to the workpiece. The device monitors the movement of the workpiece regardless of its position. An important condition for processing is the synchronization of rotations. When the synchronization is violated, the formation of shape errors in the cross section of the neck in the form of an oval or facet is possible. The complexity of the implementation of this scheme does not allow to recommend its use in terms of repair production.

2. It is much easier to implement the scheme of dependent monitoring by the grinding device for the movement of the connecting rod neck. It involves binding the

grinding device to the object of processing, which is in this case the leading element. The device that implements this scheme includes detachable brackets carrying a grinding head resting on the neck of the part. The device is kept from turning by means of a movable rod and a support of the machine. The longitudinal feed of the grinding wheel can be carried out by moving it along the axis of the neck or perpendicular to it. Longitudinal feed is used in known devices. However, the devices that implement this scheme are not structurally perfect. They have a large spindle assembly, which reduces the stiffness and contributes to the formation of errors in the shape of the longitudinal section, often barrel-shaped. In addition, the dimensions of the grinding wheel should be chosen so as to ensure the overlap of traces of processing when moving it between the cheeks of the part. As the size of the wheel decreases, it is necessary to increase the frequency of its rotation to speeds acceptable for grinding. Even for large diameter parts, such circuits require the installation of an accelerator (multiplier). This creates additional technical difficulties more, increases the size of the device, reduces the reliability of its work.

Based on this analysis, we can conclude that the most promising for repair production is the scheme of rotation of the part around the axis of the root neck when directly installing the grinding device on the connecting rod neck. This ensures the installation of a grinding wheel tangential to the surface of the neck. The adopted processing scheme is highlighted in the figure by additional lines.

1.2 Conclusions and objectives for the study

Analysis of literature data showed that:

1. The existing technology of processing of flat surfaces in repair production is labor-consuming and does not provide necessary accuracy and quality of the processed surface.

2. Known from the periodical and patent literature grinding devices are not used for machining large parts due to their structural complexity and low performance to

ensure the accuracy of the machined surface.

3. The most expedient scheme should be considered end treatment of the grinding wheel. It provides the minimum sizes of the grinding device of rather simple design.

The aim of the study is to increase the accuracy and productivity of the process of processing large flat surfaces in terms of repair production.

To achieve this goal it is necessary to solve a number of problems:

1. To develop the most rational kinematic scheme of regrinding of worn out flat surfaces that satisfies repair production on exact parameters and complexity of processing.

2. Identify the most significant factors affecting the accuracy and productivity of grinding and determine how to control the initial parameters of the machining process.

2 RESEARCH PART

2.1 Development of the scheme of grinding of flat surfaces

Analysis of methods of processing connecting rod necks of flat surfaces showed that the most rational for implementation in terms of repair production is a scheme that includes the following movements:

1. Rotation of a circle around its own axis is the main cutting motion.
2. Rotation of a detail - circular giving.
3. Reciprocating movement of the circle tangential to the treated surface of the neck - longitudinal feed.
4. Periodic movement of the circle in the direction perpendicular to the treated surface of the neck - the transverse feed.

The specifics of processing according to the adopted scheme is that the geometric accuracy of the neck of the part and the productivity of the grinding process will significantly depend on the ratio of the speeds of the tangential motion of the grinding wheel and the rotation of the part.

To identify these dependences, consider the traces of contact of the tool on the scan of the treated surface. During the period of one double stroke of the grinding wheel on the surface of the neck of the part a trace is formed, which is an elongated oval. The area of the trace is determined by the wall thickness of the grinding wheel. When the tool moves repeatedly, the tracks may overlap and mix relative to each other. One of the main conditions for ensuring the geometric accuracy of the neck is the uniform distribution of traces of processing over its entire surface.

Consider the mechanism of formation of traces of processing from the initial position circle, when the axes of the tool and the parts intersect. The workpiece 1 and the tool 2 rotate around their axes with frequencies nd and nk, respectively. The grinding wheel also has a reciprocating feed along the tangent to the workpiece surface from the initial position I to the upper position II and back. In the initial position, a circle with radius R completely overlaps the length of the workpiece neck lsh. In the absence of feed S, the wheel processes on the workpiece two strips with a width h corresponding to the wall thickness of the grinding wheel. Contact of the tool with preparation is carried out on lines A1A2 and A3A4. When the circle moves up, these contact lines are shifted and converge at point A5 ', when the amount of movement is equal to the radius R. Further movement of the circle in the same direction is not advisable, as it leads to a rupture of contact between the tool and the workpiece. The outer and inner diameters of the circle form arcs of semi-ellipses on the scan of the neck of the part. When the reciprocating motion of the grinding wheel is repeated, the traces are repeated.

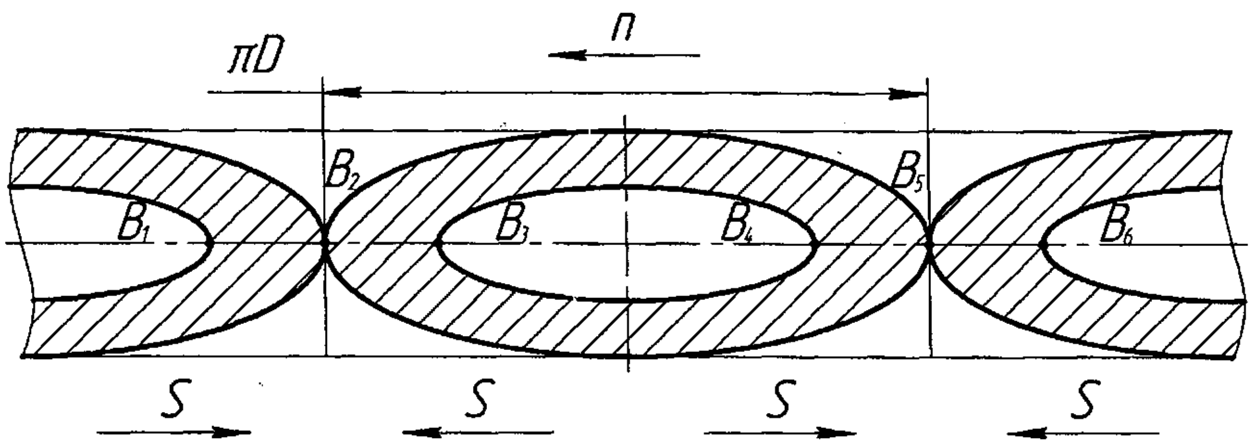

Figure 2.1 - Placement of traces of the grinding wheel when moving on the magnitude of its radius

Point A5 of the tool corresponds to points B2 and B3 at rotary-translational movement of a grinding wheel on half of diameter.

2.2 Calculation of kinematic parameters of the grinding wheel

One of the conditions for ensuring accuracy is the uniform overlap of the tool contact spots on the scan of the neck surface. Obviously, the location of the contact spots depends on the ratio of the rotational speed of the part and the speed of reciprocating movement of the tool. The picture of an arrangement of spots of contact is presented. When the overlap of the central previously untreated sections B3B4 occurs after two further rotations of the part. In total, two turns of the part have already been made, as the ratio of the lengths B3B4 and B2B3 is two. Thus, the complete overlap of the treated surface occurs after four revolutions. Then the re-imposition of contact spots begins. The first series of contact spots after the first rotation of the part is shown by solid lines 3 and 3 'and inclined from left to right when moving up by hatching. After the second rotation of the contact spotting part, it is depicted by hatching dashed lines 4 and 4 'shaded in the opposite direction. The third series of spots is marked in the form of points 5 and 5 'with vertical hatching, the fourth - dashed lines 6 and 6' with horizontal hatching.

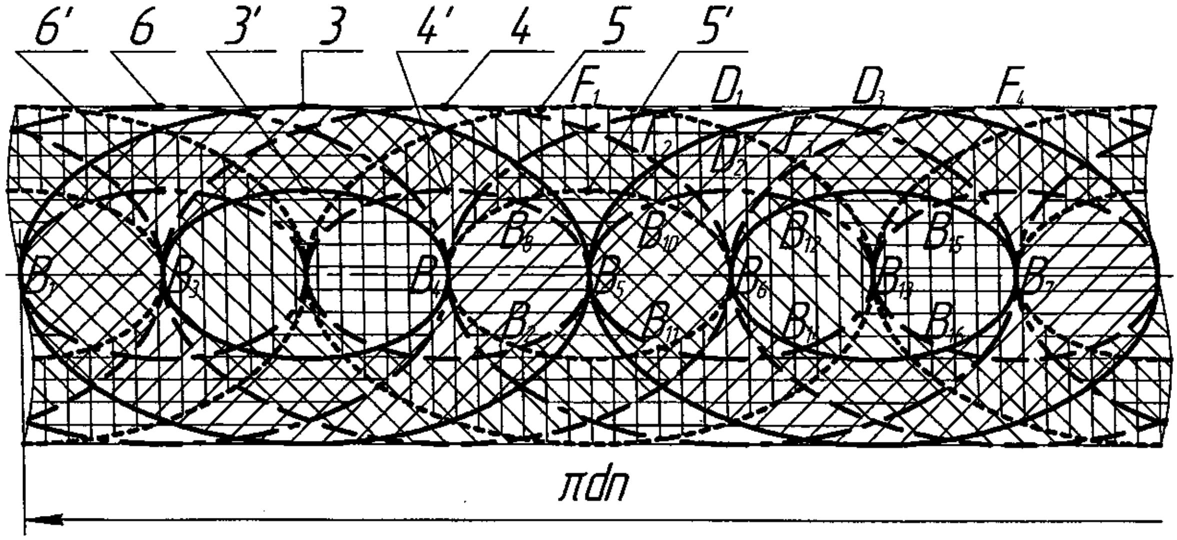

Figure 2.2 - Location of the contact spots of the grinding wheel on the part at n = 4 h = R / 2.

Overlapping of the central sections along the length of B3B4 occurs after three rotations of the part, with uneven (single and double) overlapping of contact spots on sections B3B4 and B3B8B5. In addition, there are areas at the sides of the workpiece (D1F3D3), which were not processed F1 and F4, which were processed only once. Plots F2 and F3 were treated twice. As a result, again there is an uneven imposition of contact spots, which is a prerequisite for the formation of shape error. With a further increase in processing time, the imposition of contact spots is repeated.

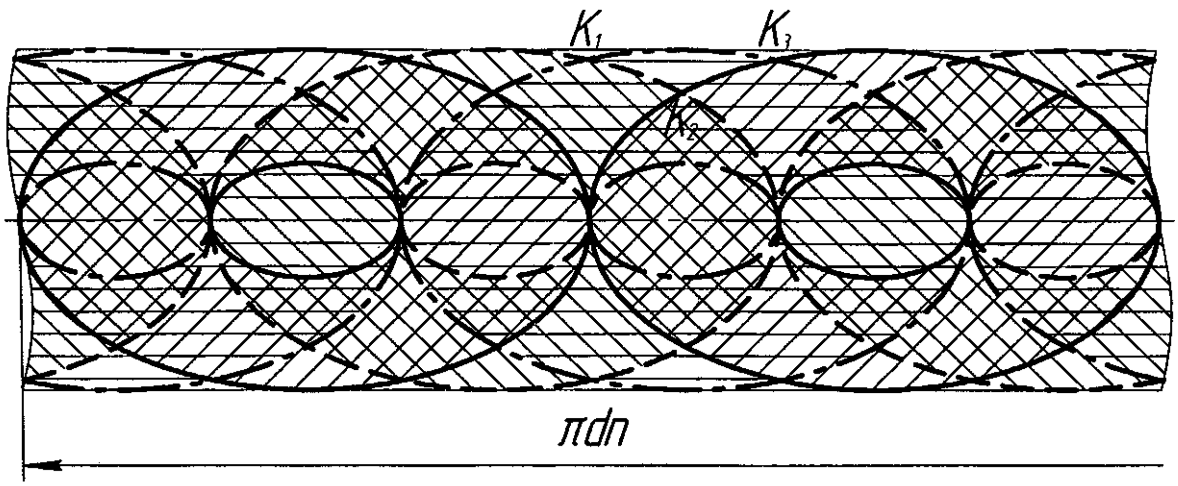

Figure 2.3 - Location of the contact spots of the grinding wheel on the part at n = 3 h = 2R / 3.

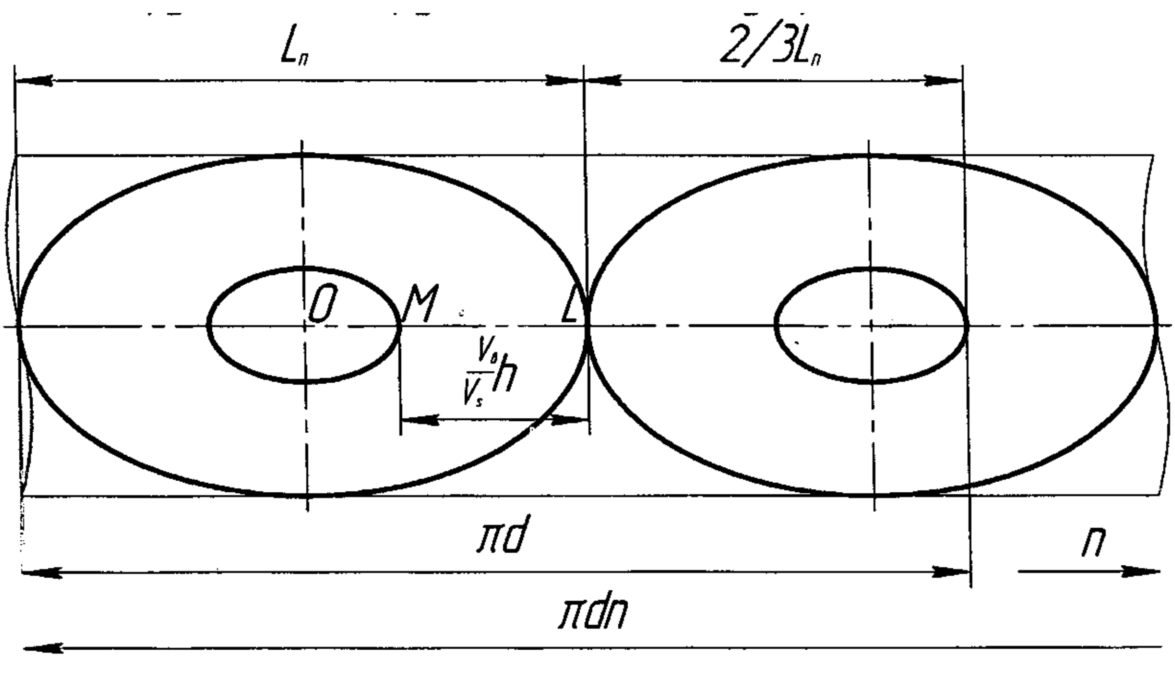

Figure 2.4 - Location of the contact spots of the grinding wheel on the part.

After the fourth turn, the details of the overlap of the contact spots are partially aligned. Here, sections F2, B5B6, B13B14 are treated twice. At the same time, sections D1D3 received a single treatment, N1 - three times, B10 - four times. This uneven overlap of the contact spots on the scan of the processed neck leads to uneven removal of metal and the formation of shape errors.

Based on the above, we can assume that to increase the uniformity of the removal of metal from the surface of the neck, the imposition of traces of processing in repeated passes should occur with some shift relative to the previous ones. The amount of shear depends on the size of the wheel: its thickness h, the outer radius R and is set by the speeds of the relative motion of the grinding wheel and the neck of the part.

At tangential movement of a grinding wheel on size of radius R with average speed Vs time is spent:

$$t = \frac{R}{V_S}.$$

During the same period of time, each point on the neck of the crankshaft will move to the value of OL:

$$OL = \pi dnt = \frac{V_B}{V_S} \cdot R,$$

where d is the diameter;

n is the speed of rotation of the part;

Vb is the speed of relative movement of the neck of the part.

Thus, for one revolution of the crankshaft grinding wheel makes m double strokes, then to ensure the shift of the trace by the value of h at subsequent rotations of the part, the condition must be met:

$$\pi d = m \cdot \frac{V_B}{V_S} \cdot 2R - \frac{V_B}{V_S} \cdot h,$$

where m is the relative frequency of reciprocating motion of the circle.

After performing simple transformations, we obtain:

$$\pi d = m \cdot \frac{V_B}{V_S} \cdot (2Rm - h) = \frac{\pi dn}{2Rf} \cdot (2Rm - h),$$

where f is the frequency of reciprocating motion of the grinding wheel, which is determined by the formula, depending on the speed of rotation of the crankshaft:

$$f = n\left(m - \frac{\bar{h}}{2}\right),$$

where = h / R is the relative thickness of the grinding wheel.

The assessment of the uniformity of metal removal can be carried out according to two criteria: the coefficient of overlap Kp and the coefficient of imposition of contact spots Kn.

The overlap coefficient Kp determine the ratio of the total area of traces of processing to the surface area:

$$K_п = \frac{F_\Sigma \cdot i}{\pi d l_ш},$$

where FΣ is the area m of traces of processing on the scan of the part in one revolution;

and - the number of revolutions of the part, which provides complete overlap of the surface of the neck with traces of processing;

$$l_ш = 2R.$$

According to the dependence:

$$F_\Sigma = m\left(4\int_0^R \frac{V_в}{V_s}\sqrt{R^2 - y^2} \cdot dy - 4\int_0^r \frac{V_в}{V_s}\sqrt{r^2 - y^2} \cdot dy\right) - 2\int_0^{y_1} \frac{V_в}{V_s}\sqrt{R^2 - y^2} \cdot dy,$$

where r = R - h is the inner radius of the grinding wheel.

Perform the solution of the equation in terms of, denoting:

$$F_1 = 4\int_0^R \frac{V_в}{V_s}\sqrt{R^2 - y^2} \cdot dy; F_2 = 4\int_0^r \frac{V_в}{V_s}\sqrt{r^2 - y^2} \cdot dy; F_3 = 4\int_0^{y_1} \frac{V_в}{V_s}\sqrt{R^2 - y^2} \cdot dy;$$

When calculating the first application, we assume y = R - sint, then dy = = R · cost · dt, t = arcsin (y / R), when y = 0, t = 0, y = R, t = p / 2. Then:

$$F_1 = 4\int_0^R \frac{V_в}{V_s}\sqrt{R^2 - y^2}\cdot dy = 4\int_0^{\frac{\pi}{2}} \frac{V_в}{V_s}\sqrt{R^2 - R^2\cdot\sin^2 t}\cdot R\cdot \cos t\cdot dt =$$

$$= 4\frac{V_в}{V_s}R^2\int_0^{\frac{\pi}{2}}\sqrt{1-\sin^2 t}\cdot\cos t\cdot dt = 4\frac{V_в}{V_s}R^2\int_0^{\frac{\pi}{2}}\cos^2 t\cdot dt =$$

$$= 4\frac{V_в}{V_s}\cdot\frac{R^2}{2}\int_0^{\frac{\pi}{2}}(1+\cos 2t)\cdot dt = 4\frac{V_в}{V_s}\cdot\frac{R^2}{2}\left(t+\frac{\sin 2t}{2}\right)\Bigg|_0^{\frac{\pi}{2}} = 4\frac{V_в}{V_s}\cdot\frac{R^2}{2}\cdot\frac{\pi}{2},$$

$$F_1 = \frac{V_в}{V_s}\pi R^2 = \frac{\pi dn}{2R\cdot f}\pi R^2 = \frac{n}{2f}\pi^2 dR.$$

When calculating the second application, we assume y = R - h, then dy = (R– - h) cost - dt, t = arcsin (y / (R - h)), when y = 0, t = 0, y = R - h, t = p / 2. Then:

$$F_2 = 4\int_0^r \frac{V_в}{V_s}\sqrt{r^2 - y^2}\cdot dy = 4\int_0^r \frac{V_в}{V_s}\sqrt{(R-h)^2 - (R-h)^2\cdot\sin^2 t\cdot(R-h)\cdot\cos t\cdot dt},$$

$$F_2 = \frac{n}{2f}\pi^2 d(1-\bar{h})^2 R,$$

where = h / R is the relative width of the end face of the grinding wheel. Define the boundaries of integration to solve the third application:

$$y_1 = \sqrt{R^2 - (R-h)^2} = \sqrt{2Rh - h^2} = R\sqrt{2\frac{h}{R} - \left(\frac{h}{R}\right)^2} \approx R\sqrt{2\bar{h}},$$

where (h / R) 2 - is a second-order value and can be ignored in the calculations.

Then $0 \le y \le R\sqrt{2\bar{h}}$: $F_3 = 2\int_0^{R\sqrt{2\bar{h}}} \frac{V_в}{V_s}\sqrt{R^2 - y^2}\cdot dy.$

When calculating the third application, we assume y = R, then dy = R · cost · dt, t = arcsin (y / R), when y = 0, t = 0, y = R, t = arcsin. Then:

$$F_3 = 2\int_0^{\text{arksin}\sqrt{2\bar{h}}} \frac{V_в}{V_s}\sqrt{R^2 - R^2\sin^2 t}\cdot R\cdot\cos t\cdot dy,$$

$$F_3 = \frac{n}{2f}\pi dR\left(\text{ark}\sin\sqrt{2\bar{h}} + \sqrt{2\bar{h}}\right).$$

According to the equation:

$$F_\Sigma = m(F_1 - F_2) - F_3,$$

$$F_{\Sigma} = m\left[\frac{n}{2f}\pi dR - \frac{n}{2f}\pi^{2}d\left(1-\bar{h}\right)^{2}R\right] - \frac{n}{2f}\pi dR\left(\arcsin\sqrt{2\bar{h}} + \sqrt{2\bar{h}}\right) =$$

$$= \frac{n}{2f}\pi dR\left[\pi m\bar{h}\left(1-\left(1-\bar{h}\right)^{2}\right) - \arcsin\sqrt{2\bar{h}} - \sqrt{2\bar{h}}\right],$$

$$F_{\Sigma} = \frac{n}{2f}\pi dR\left[\pi m\bar{h}\left(2-\bar{h}\right) - \arcsin\sqrt{2\bar{h}} - \sqrt{2\bar{h}}\right].$$

The minimum number of revolutions of the part and determine from the condition of overlapping traces of processing of the middle part of the neck:

$$i = \frac{\frac{V_{в}}{V_{s}}2Rm - \frac{V_{в}}{V_{s}}h}{2\frac{V_{в}}{V_{s}}h} = \frac{2Rm-h}{2h} = \frac{Rm}{h} - 0.5,$$

$$i = m/\bar{h} - 0.5.$$

The overlap coefficient is determined from the expression:

$$К_{п} = \frac{n\pi dR\left(\pi m\bar{h}\left(2-\bar{h}\right) - \arcsin\sqrt{2\bar{h}} - \sqrt{2\bar{h}}\right)\cdot\left(m/\bar{h} - 0.5\right)}{2f\pi d\cdot 2R} =$$

$$= \frac{n\left(\pi m\bar{h}\left(2-\bar{h}\right) - \arcsin\sqrt{2\bar{h}} - \sqrt{2\bar{h}}\right)\cdot\left(m/\bar{h} - 0.5\right)}{4f}.$$

Substituting the value in equation $f = n\left(m - \bar{h}/2\right)$ we obtain:

$$К_{п} = \frac{n\left(\pi m\bar{h}\left(2-\bar{h}\right) - \arcsin\sqrt{2\bar{h}} - \sqrt{2\bar{h}}\right)\cdot\left(m/\bar{h} - 0.5\right)}{4n\left(m - \bar{h}/2\right)},$$

$$К_{п} = \frac{\pi m\bar{h}\left(2-\bar{h}\right) - \arcsin\sqrt{2\bar{h}} - \sqrt{2\bar{h}}}{4\bar{h}}.$$

The dependence of the overlap coefficient calculated by formula for the values of h = 0.3 ... 0.5 and m = 1 ... 5, are shown. Analysis of the curves shows that with increasing number of double strokes t, the overlap coefficient increases, which indicates an increase in the productivity of the processing. As the relative thickness of the circle increases, the overlap coefficient increases slightly. When the value = 0.3 ... 0.5, these changes can be ignored. The final choice of the size of the circle and the number of double strokes can be made after determining the coefficient of overlap, which characterizes the uneven removal of metal on the surface of the neck. The overlap coefficient is defined as the ratio of the number of maximum layers of contact spots to the minimum in randomly selected areas of the neck. The value of this coefficient can be determined by considering the picture of the location of the contact spots on the neck of the part, obtained by graphical construction for the given values

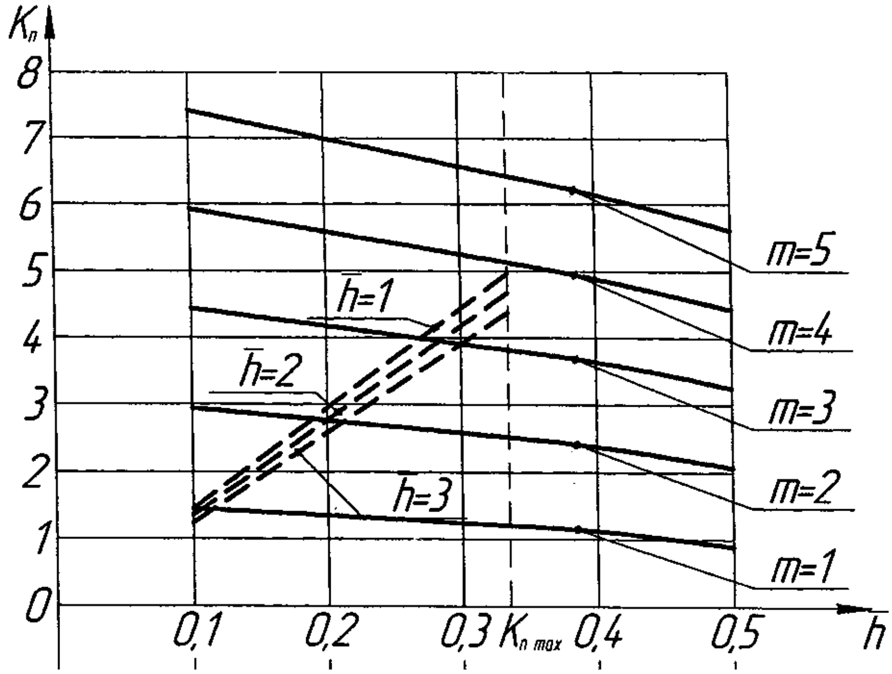

Figure 2.5 - Dependence of the overlap coefficient Kp on the thickness grinding wheel and the number of double strokes m.

The analysis shows that the smallest value of the coefficient Kn = 1.5 corresponds to the values of h = 0.3 ... 0.5 and m = 2. The nature of the distribution of contact spots at m = 2 and h = 0.3 is shown in Fig. 4.9.

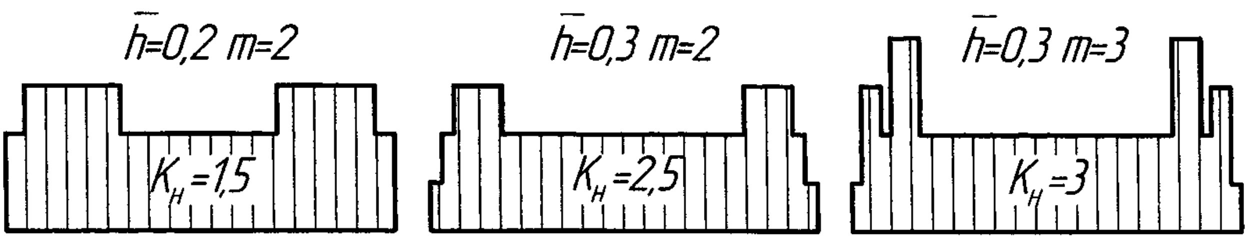

Figure 2.6 - Plotting traces of processing when changing the number of double strokes m of the grinding wheel

The figure shows that on the middle part of the neck there is a double imposition of contact spots, amin = 2. Near the fillets of the part the number of imposition amin = 3.

$$K_{и} = \frac{a_{max}}{a_{min}} = 1.5.$$

The other ratio of the size of the circle and the number of double strokes increases the coefficient of overlap to 2.5 ÷ 3, without distorting the nature of the pattern of overlapping spots.

2.3 Calculation of the law of tangential movement of the grinding wheel

At repeated movement of a circle all surface of a neck is exposed to processing. Grinding ends with complete restoration of the roundness of the neck, which is visually determined by the occurrence of a continuous flow of sparks.

The alignment of the removable metal layer along the processing neck is carried out by adjusting the speed of tangential movement of the circle. One of the main causes of shape error in the longitudinal section of the neck (deviation from the cylindricality) is the uneven contact time of the tool with the surface of the neck along the forming. The distribution of contact time in fractions of the period t / T (where t is the current processing time, T is the period of tangential movement of the circle) is shown in the figure. The scheme of interaction of a grinding wheel and the processed surface at uniform tangential movement is shown in drawing.

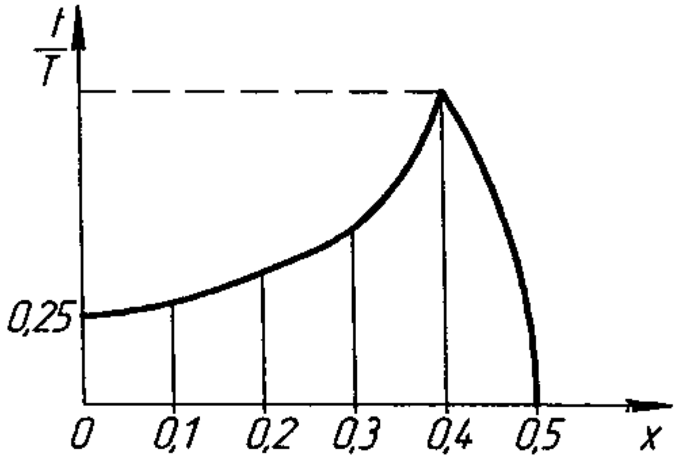

Figure 2.7 - Distribution of the contact time of the grinding wheel along the axis during uniform movement.

Let y (t) be the equation of motion of the grinding wheel in the fourth part of the period. The grinding time of the neck in the section I - I corresponds to the time of movement of the circle on the way from point A 'to point A ". These points correspond to the shear value y1. To calculate the grinding time Z of the cylinder in the section I - I Z = t (yA ",) - t (yA ') where the values of y are equal to the limit values at points A' and A ". This formula holds for R– h≤ x≤R. With the value of y we compare the points on the outer and inner circles and proceed to the calculation of the extreme values of i on the intervals of change x0≤x2≤R - h where x0 is determined by the greatest distance y0 in the periodic motion of the grinding wheel. The time Z for different sections of the cylinder is determined by the intervals of change:

$R - h \le x_1 \le R_1$, $\qquad Z(x) = t\left(\sqrt{R^2 - x^2}\right)$,

$\sqrt{R^2 - y_0^2} \le x_2 \le R - h$, $\qquad Z(x) = t\left(\sqrt{R^2 - x^2}\right) - t\left(\sqrt{(R-h) - x^2}\right)$,

$0 \le x_0 \le \sqrt{R^2 - h^2}$, $\qquad Z(x) = t(y_0) - t\left(\sqrt{(R-h) - x^2}\right)$.

Analyzing the obtained dependences, we can conclude that equations cannot simultaneously satisfy the condition of constant contact time, ie it is impossible to choose the function t (y) so that in the first and second cases it satisfies the condition Z = const . The interval is the longest in this case, so the condition Z = const must first withstand the equation $t\left(\sqrt{R^2 - x^2}\right) - t\left(\sqrt{(R - h)^2 - x^2}\right) = const.$ Replacing R2 – x2 = ξ, 2Rh – h2 = $t\left(\sqrt{\xi}\right) = f(\xi),$ = a, we obtain $f(\xi) - f(\xi - a) = const$. For monotonic functions, the condition is possible only in the case of linear dependence. Then the function will take the form:

$$t = Ay^2 + B.$$

Let's move on to dimensionless coefficients, replacing:

Let the origin correspond to the position of the circle when its axis intersects with the axis of rotation of the part at an angle of 90 °. Then the boundary conditions can be expressed in terms of: at t = 0 y = 0; when t = T y - y0, here T is the time of movement of the circle to the final position. Substituting into the expression, we obtain from the first condition 0 = A · 0 + B. But t = 0 only if B = 0. From the second condition T - A · R2 then A = T / R2. Substituting A and B in the equation, we obtain:

$$t = \frac{T}{y_0^2} \cdot y^2 = \frac{T \cdot y^2}{R^2 - x_0^2}.$$

Let's move on to dimensionless coefficients, replacing:

$$\bar{x} = \frac{x}{R}, \bar{x}_0 = \frac{x_0}{R}, \bar{y} = \frac{y}{R}, \bar{y}_0 = \frac{y_0}{R},$$

$$t = \frac{T \cdot \left(\frac{y}{R}\right)^2}{1 - \left(\frac{x_0}{R}\right)^2} = \frac{T \cdot \bar{y}^2}{1 - \bar{x}_0},$$

then

$$\tau = \frac{t}{T} = \frac{y^2}{1 - x_0^2}.$$

or

If, based on the condition of achieving the greatest productivity of the process, take the course of the circle equal to R then x0 = 0 and the dependence will look like. The contact time of the end of the grinding wheel with the surface of the neck along its generator is distributed according to the law presented in Fig. 2.8.

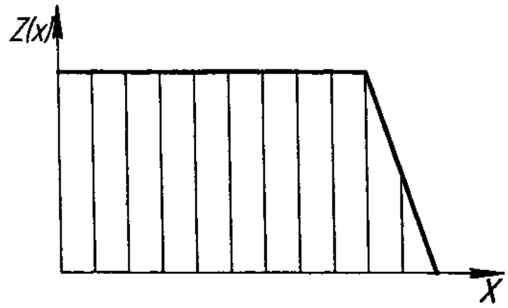

Figure 2.8 - Distribution of the interaction time of the grinding wheel and the part

It can be seen from the graph that in order to align the removable metal layer, the grinding wheel must be fed at least half of the diameter, ie take the value $y_o \leq R$. Moreover, the movement of the grinding wheel from the center to the periphery should be carried out slowly in dependence and return to the starting position is accelerated along a symmetrical curve. Here, the time in fractions of the period varies from 0 to 1 when removing the center of the circle from the processing area and from 1 to 2 when approaching. After each double stroke of the grinding wheel it is necessary to make its short-term stop before full turn of a detail for processing of the transition sections h located at dumbbells. The calculated law of movement of a grinding wheel is put in a basis of the device with the hydraulic drive and system of automatic control of speed of movement.

Finally, the necks of the parts are treated with abrasive bars according to the scheme of shock-cyclic superfinishing, which provides in addition to axial radial oscillations of the bars from the vibrator. The scheme provides dimensional processing of details without signs of salting of bars. As a result of such processing high geometrical accuracy of necks and surface roughness is provided.

Grinding and super-finishing devices are mounted on opening brackets, which have roller supports on the dumbbells of the neck not prone to wear. The devices are installed on the caliper of a lathe with a height of the centers not less than 600 mm.

3 TECHNOLOGICAL AND DESIGN PART

3.1 Characteristics of design details produced for performance manufacturing process

Detail is classified buildings. It has a complex configuration and is part of one of the optical-mechanical devices.

On the plane K set cover that has holes ∅22 $I_9$7. They destination is for installing pulleys, which in turn are purpose-based vertical plane.

For efficiency of the device requires that the holes ∅22 $I_5$7 in the trunk lid were coaxial together the boundaries of 0.02 mm parallelism of axes that pass through these openings should be no more than 0,02mm.

In addition, the components are surface M 45×0,75 which twists another node optical-mechanical device with centering on ∅43-48. Need to surface axis M 45×0,75, ∅43-48 are perpendicular to the axis passing through the hole in the borders 0,02mm.

Other surfaces appointment for installation and mounting of a number of parts and components of the device. To ensure the technological requirements on placement surfaces, provides heat treatment. In order to provide the details of the decorative appearance and protection against environmental coverage is carried, anodic oxidation; exterior surfaces are covered. ML-165, silver Hug III.

Material of – AL2 GOST 2685-75. Group rafting – and possesses the highest linear properties, ductility and sufficient mechanical strength, good corrosion resistance.

Table 3.1 – Chemical composition AL2 GOST 26-85-75

Si	Mg	Zn	Mn	Cu	Fe	
10-13	0.1	0.3	0.5	0.6	Casting in shell form	Die-casting
					0.7	1.5

Table 3.2 – Mechanical properties AL2

Gb Pa		δ,%		MB, MPa	
cast	After heat treatment	cast	After heat treatment	cast	After heat treatment
100	150	2,1	3,2	490	490

3.2 Analysis of the technological design

Detail is classified buildings. The starting billet is casting aluminum alloy AL2 GOST 2685-76. Overall dimensions of the body and its parts are relatively small (160×87×235). A small mass of the body – 1.31 kg.

Accuracy of base size holes quality, roughness 2-2.5mkm. The accuracy of + 0.1 mm between the pivot distances. Adjusting surface - flat; multiple axes through holes parallel to the plane docked.

Detail adjusting strong and rigid methods allows you to perform highly - productive processing.

On the outside parts are ribs. When handling this will help reduce deformation of the workpiece when mounted and help to process high cutting modes or multiple tools simultaneously. This rise precision and surface quality.

3.3 Determination of the type of production

Type of production, the most common organizational and technical characteristics of production determined by degree of specialization of production locations, production facilities nomenclature, shape choice movement in the workplace.

Types of production determined by the coefficient of consolidation of operations - K30, which shows the relationship between labor input performed all the various manufacturing operations performed during the year and productivity jobs destined for the technological process of loading the condition of the equipment in accordance with the regulatory factors.

To determine the type of production use data on existing technological process that tabulates.

Output data

1. The number of parts in the product. M = 1pc.
2. Mode enterprises. 23tons in day.
3. The annual program details. Where = 1080 pieces.

Table 3.3 – Data on existing factory manufacturing process

Operation	T-pieces. min	Shr.	P	η_3l	O
1	2	3	4	5	6
Vertical mirror	3.63	0,02	1	0,02	35,9
Routers	1,14	0,063	1	0,063	11,02
drilling	2,20	0,043	1	0,043	20,8
Milling	3,26	0,068	1	0,068	11,92
Drilling	1,70	0,03	1	0,03	25
Routers	4,05	0,044	1	0,044	20,6

End of Table 3.3

1	2	3	4	5	6
Routers	2,72	0,036	1	0,036	27,1
Milling	3,69	0,052	1	0,052	17,1
Milling	4,15	0,048	1	0,048	34,4
Milling	6,19	0,068	1	0,068	12,9
Jig-boring	11,78	0,099	1	0,099	7,01
Lathe	10,54	0,081	1	0,081	18,9
Lathe	5,82	0,065	1	0,065	19,05
Vertical drilling	9,19	0,079	1	0,079	8,62
threading	11,03	0,092	1	0,092	7,45
Total	86,15		15		262

Determine the number of machines under the formula:

$$SH_r = \frac{D_s \cdot T_{pieces.k.}}{60 \cdot F_d \cdot \eta_{zn}},$$

where T_{pieces} calculation artificially the operation in minutes.

F_d – actual annual fund operating time of equipment; F_d = 3904 hours.

η_{zn} – the load factor of equipment.

η_{zn} – 0.75.

I pallets

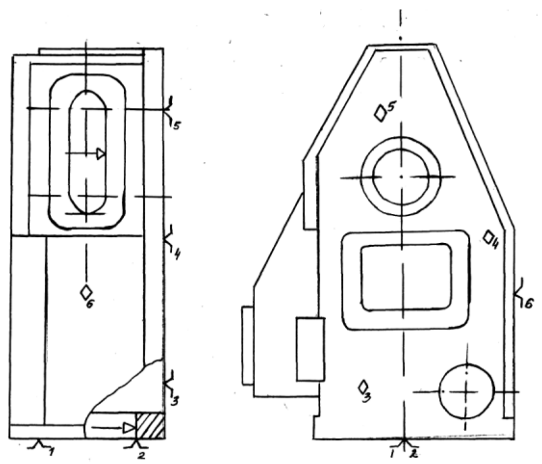

Figure 3.1 – Details on the deployment of software and combined surgery and pallets.

II Pallets

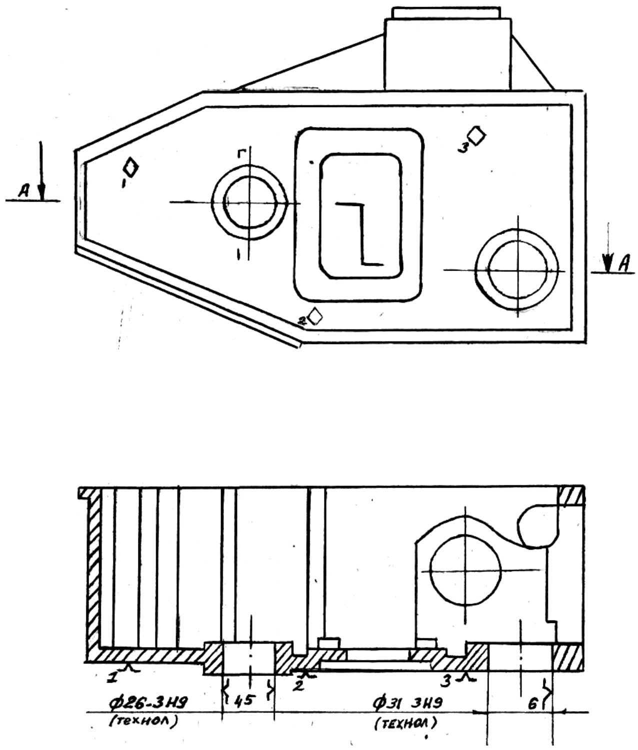

Figure 3.2 – Chart deployment details on program-combined operation on the second pallet

III Pallets

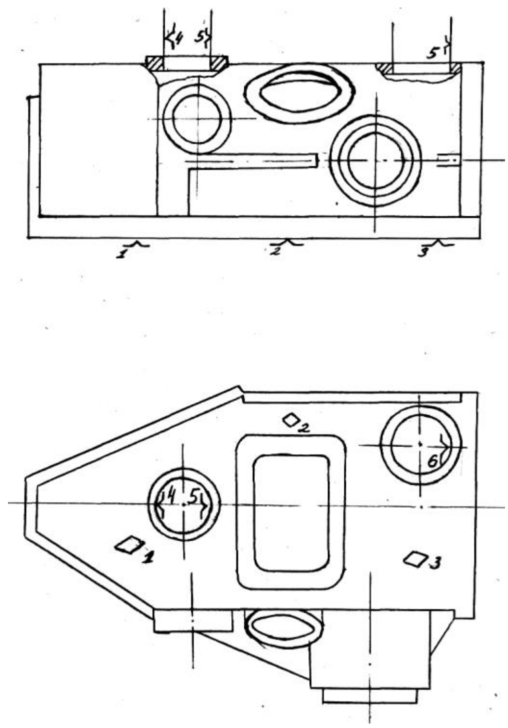

Figure 3.3 – Scheme details on deployment of software and combined operations in the third pallet

The resulting number of machines tabulates.

Determine the value of each transaction load factor workplace by the formula:

$$\eta_{zf}=mp/pi.$$

The results tabulate.

The number of operations performed on the job determined by the formula:

$$O= \eta_{zn}/\eta_{zf}.$$

The data are entered in the table.

Determine the coefficient of consolidation of operations which, in accordance with GOST 3.1108-74 group of jobs is determined by the formula.

$$K_{CO}=\Sigma O/\Sigma p=262/15=17{,}46.$$

Tk $10 < K_{CO} < 20$, according to GOST M004-74 determine what type of production – serial medium.

3.4 Selecting a method for producing blanks

The choice of method for producing billets in most cases determines the desired mechanical processing, labor-intensive and cost.

Detail of the "body" refers to parts which tend mainly to obtain pieces by casting or stamping. Given the complexity of configuration and the fact that the basic plant billet obtained by casting let the first option that will serve as billet casting.

Casting this configuration can be obtained by casting into the ground; molding, injection molding.

For comparison, we choose two options for casting: in shell form and injection molding. Write a brief description of them.

Casting in shell form is used for obtaining essential molded castings – minimum thickness – 1-1.5mm., Accuracy - the boundaries of 12-14 tolerance degree on “СТСЭВ 144-75”. Roughness parameters Rz = 40.

Rz +I= 40+200 (mcm).

Injection molding is used for shaped castings of aluminum alloys – minimum thickness - 0.5 mm accuracy - the boundaries of the 11-12th rate GOST 144-75 parameters stiffness Rz - 20.

RzтT = 20+140 mcm.

Cost piece obtained by casting in shell form

$$S\ total = ((C / 100) \times Q \times kt \times kc \times kn \times km \times kb) \times (Q - q) \times S_{vidh} / 1000;$$

where C - the base price workpiece 1m UAH.

kt - factor depending on the class accuracy of 1,11 kt

Ks - coefficient depending on the group of complexity, Ks - 0.82.

kb - coefficient that depends on the mass kb = 1.

km - factor depending on the grade of material, km = 1,94.

kn - coefficient depending on the volume of production;

Q - weight of the workpiece; Q = 2,12kh.

q - the mass of detail, q - 1,31kh.

S_{vidh} - 1 price you waste S_{vidh} UAH = 2400 UAH.

S total = ((1205/1000) x 2.12 x 1.1 x 0.82 x 1 x 1.94 x 1) x (2.12-1.31) x 2400/1000 = 34.3 UAH.

Himself blank value obtained by injection molding.

S total = ((C / 100) x Q x kt x kc x kn x km x kb) x (Q -q) x S_{vidh} / 1000;

C - Cost base 1ty workpiece, rub. C1 = 1265.

kt - factor depending on the class accuracy kt = 1,1.

Ks - Coefficient that depends on the complexity of the group, kc = 0, 88.

kb - coefficient that depends on the mass, kb = 0,75.

km - factor depending on the grade of material: km = 1

kn - coefficient depending on the volume of production kn = 1,09.

Q - weight of the workpiece, Q = 1,31 kg.

q - the mass of detail, q = 1,31kh.

S_{vidh} - the price of 1 ton of waste rub. S_{vidh} = 2400 UAH.

S total = ((1265/1000) x 1.69 x 1.1 x 0.88 x 0.75 x 1.09 x 1) x (1.69-1.31) x 2400/1000 = 16.0 UAH.

Table 3.4 - Characteristics of methods for harvesting

Indicator	For project	For analysis
Type blanks	Die-casting	Casting in shell form
accuracy	2	2
Group serial	3	3
Group of complexity	3	3
Weight piece, kg	1,69	2,12
The cost of 1 You chips, UAH.	2400	2400
The cost of harvesting, UAH	160	343

Economic effect comparing methods. Getting a piece in which the technical process of machining does not change calculated by the formula.

Э1 = (Szah1-Szah2) x N = (34.3-16.0) x 1000 = 18300 UAH.

3.4.1 Selection and justification of the technical bases

One of the most difficult and fundamental sections design processes is the designation process and measurement bases. The correct choice of technological bases largely dependent: the actual accuracy of the size specified by the designer, the degree of complexity of devices, scrolling and measurement instruments, general processing performance pieces.

Choice bases in the first operation precedes the definition of surface to be used as a base for these operations. These surfaces are usually the main base of which is usually most asked sizes, coordinating the deployment of other major surface details.

Defining the technological base for these operations is selected technological base for the first operation:

1. The base must have sufficient length;
2. The harvesting should take some adjustment in her position under its own weight, and not as a result earned efforts;
3. The basic parts of the surface should be to ensure the uniqueness of deployment;
4. The terms of the details of the operation of base surfaces should be the most responsible;
5. The base must be capable of handling the number of installations maksyrysnoyi surfaces.

This requirement is particularly important in this case, the processing of parts on the machine UP-320.

For details of this, I first choose the basis for milling, prohamno-combined, lathe and boring operations.

The first operation is milling operation on Vertical Milling machines ВФ-57.

In this transaction we process pouring accordance with the main surface of the workpiece.

The machine UP-320 3 piece set on pallets in sequence.

Pre produce circuit-based to program-combined operation for each of the three pallets.

In establishing the details of the first pallet, we drilling window following all sizes (see sketches map) also drilling end performance, drill 6 holes along the contour of the window bore two holes Ø-26, 349, Ø -31, 349, drilling groove veneer following size drill 2 holes on the retreat, drilling groove on the ledge.

When installed on the second pallet parts we drill holes in 11 outline details drilling surface thereby remove the allowance left after molding.

When installing the parts to a third pallet we drill 4 holes bore and then cut the threads

Also drill 4 holes in the bottom of the presentation details 8 drill holes in the circuit, drill surface drill window, and make a selection.

Once we have processed a part program on the combined stall UP-320 we handle it on lathe 1K62 stall.

In lathe operations we bore hole, cut the thread, and remove the fascia. Item must be fastened in a fixture so that the centre axis of the machine spindle coincide with the centre axis boring hole.

Therefore, we detail base on adaptation and adjustment affirms in the cartridge machine.

Detail set in the adaptation, which stand Adjusting fingers. Fingers installed so that in determining the details of the adjustment strictly adhere to sizes that shown in following figure.

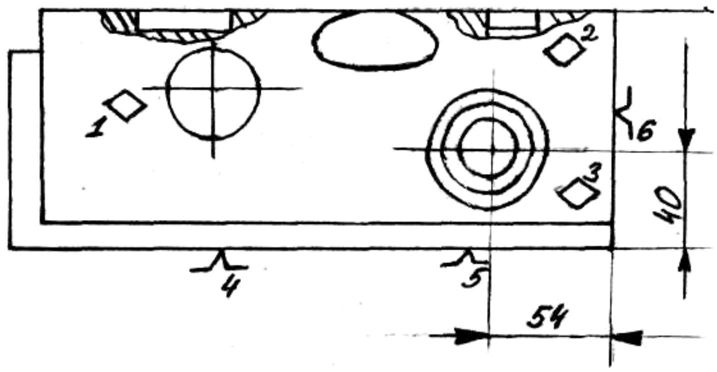

Figure 3.4 – fixing scheme details

The next operation – is a thread cutting on thread cutting machine MH-56-1.

Since all threaded holes are drilled on the MP-320, we only need to cut thread in these holes.

This operation will use a fairly simple device such position press.

Base surface will press a plane which will be pressed our part.

Scheme basing this operation will be as follows:

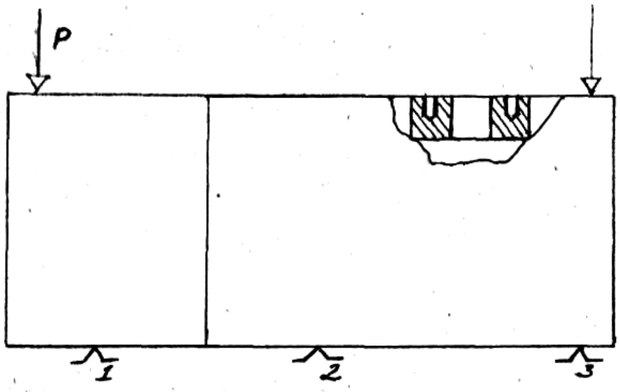

Figure 3.5 – fixing scheme details

Changing of the details we can cut all the threads in the holes designed by thread.

3.5 Calculation of allowances for machining

General allowances for machining regulated by GOST 1855 -75 and its size depends on the class of accuracy casting, casting the greatest overall dimensions and position of the considered surface shape at casting metal.

For sizes uncultivated surfaces tolerances set by LT OST 141154-72. in our case, these dimensions are casting tolerances

- Dimensions of flanges ± 0.5 mm.
- Dimensions External diameter ± 0.5 mm.

A similar calculation of allowances one internal and the external surface will accompany the graphic placement schemes.

3.5.1 Calculation of allowances on the surface ∅ 43N8

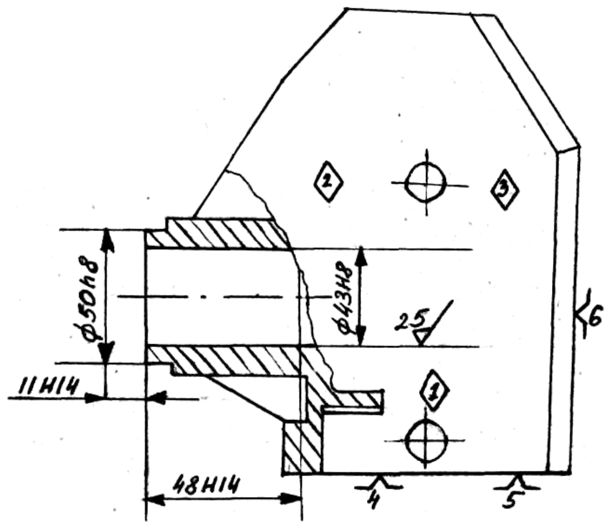

Figure 3.6 – Housing (drawing and installation diagram of the processing hole ∅43N8)

Output data

Name of parts - body

Preparation - casting

Weight - 1,69 kh

Accuracy - H8

Table 3.6 – calculation of allowances and the size limits for process transitions to processing hole ∅43N8

The technological transition surface treatment Ø 43H8	Elements allowance				Estimated allowance 2,21mcm	Estimated diameter	Admission δ	The maximum size		Limit values allowances	
	Rz	T	P	E				d min	D max	2z min	2z max
Preparation	160	160	504			41,769	500	41,269	41,769		
Boring roughing	50	50	25	95	2513	42,789	160	42,626	42,789	2,1017	2,1357
Finishing Boring	20	25		4,7	2,125	43,039	39	43	43,049	2,254	2,374

The total value of the spatial variation of this type Logging determined by the formula:

$$\rho_{st} = \delta,\ \rho_{par}\ \Delta k \times l;$$

Specific warping castings

$$\Delta k = 0.8\ (2m \times 4 \times 8);$$

l - length of machined hole.

Admission to size 40 for casting the second class δ = 500mkm. (2m, 24).

The total value of spatial deflection piece

$$\rho_z = \sqrt{\rho_{par}^2 + \rho_{zm}^2} = \sqrt{(0{,}8 \cdot 250)^2 + 500^2} = 504 \text{ mcm;}$$

Spatial final rejection after another boring ρ1 = 0,05; ρ3 = 0,05 504 =25,2mkm.

PLL with rough boring:

$$E_1 = \sqrt{Eb^2 + Ez^2}\ .$$

Where *Еб* - error based.

Еб = 30mkm.

Ez - error fixing.

Ez = 90mkm.

Then

$$\varepsilon_1 = \sqrt{30^2 + 90^2} = 95 \text{ mcm.}$$

The final error of boring at the fair:

$$E_2 = E_1 \times 0.05 = 0.05 \times 95 = 4{,}7\text{mkm.}$$

Based on the data recorded in the table do minirysnyh calculation values between operational allowances using the basic formula:

$$2Z_{min} = 2(Rz+T+\sqrt{\rho_{i-1}^2 + \varepsilon^2}\ ;$$

The minimum allowance during boring

Draft $2Z_{min} = 2 \times (50+50+\sqrt{25^2 + 4{,}7^2}\ ) = 2\cdot125$mcm.

Draft $2Z_{min} = 2 \times (160+\sqrt{504^2 + 95^2}\ ) = 2\cdot513$mcm.

Thus, with the estimated size after the last transition boring (ø43, 0,39) for other transitions obtain:

- for rough boring

$$d_{p1}=43{,}039 – 0{,}25 = 42{,}789\text{мм}.$$

- Logging

$$d_{p3}=42{,}789 – 1{,}026 = 41{,}769\ \text{мм}.$$

So for finish boring tolerance is 39mkm. And for rough boring d = 140 microns. Admission to the holes in the second casting accuracy class is δ = 500mkm

The smallest size limits determine the largest size limits subtracting tolerances appropriate transitions.

- for finish boring:

$$d_{max} = 43.039\text{mcm}.$$

$$d_{min} = 43.039 – 0.039 = 43\text{мм}.$$

- for rough boring:

$$d_{max} = 42.789\text{мм}.$$

$$d_{min} = 423.789 – 0.16 = 42{,}626\text{мм}.$$

- Logging:

$$d_{max} = 41{,}769\text{мм}.$$

$$d_{min} = 41{,}769 – 0.5 = 41{,}269\text{мм}.$$

Minimum thresholds allowances equal to the difference Z_{min}^{pr} largest size limits performed prior conversion value of the difference maksyrysni smallest size limits.

To finish boring:

$$2Z_{min2}^{pr} = 43{,}039\text{-}42{,}789 = 0{,}259mm.$$

$$2Z_{max2}^{pr} = 43\text{-}42{,}626 = 0{,}374mm.$$

For rough boring.

$$2Z_{min2}^{pr} = 42{,}780\text{-}41{,}769 = 1{,}017mm.$$

$$2Z_{max2}^{pr}\ 42.626\text{-}41{,}269 = = 1{,}357mm.$$

We provide validation of performance.

All calculation results are listed in the table. Based on calculations of building a graphic diagram accommodation allowances and tolerances on processing ∅43 h8.

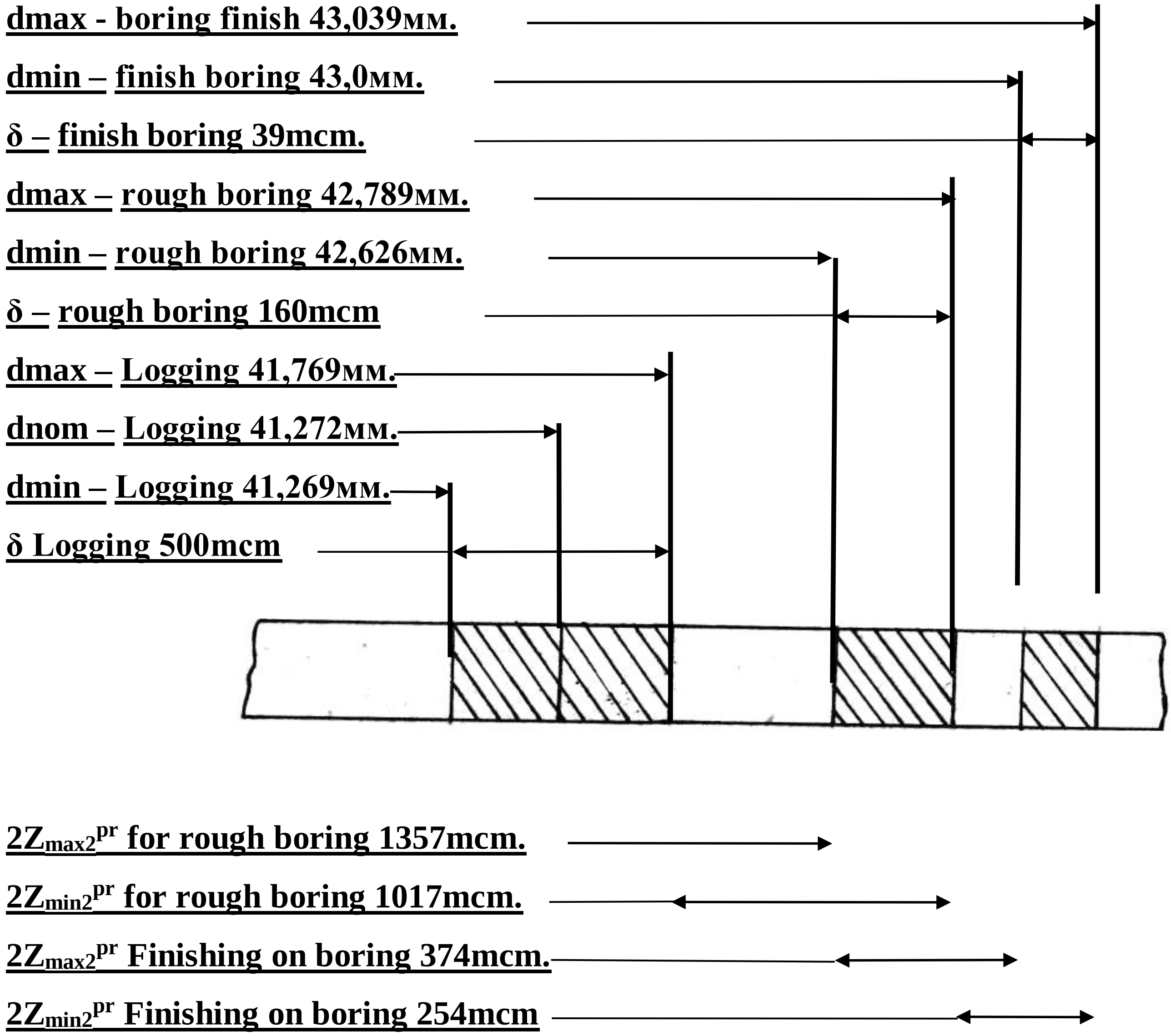

Figure 3.7 – Graphic accommodation allowances and tolerances of holes ∅43 h8 housing

3.5.2 Calculation of allowances to the surface ∅50 h8

Figure 2.8 The case drawing and layout, installation of the processing surface ∅50 h8.

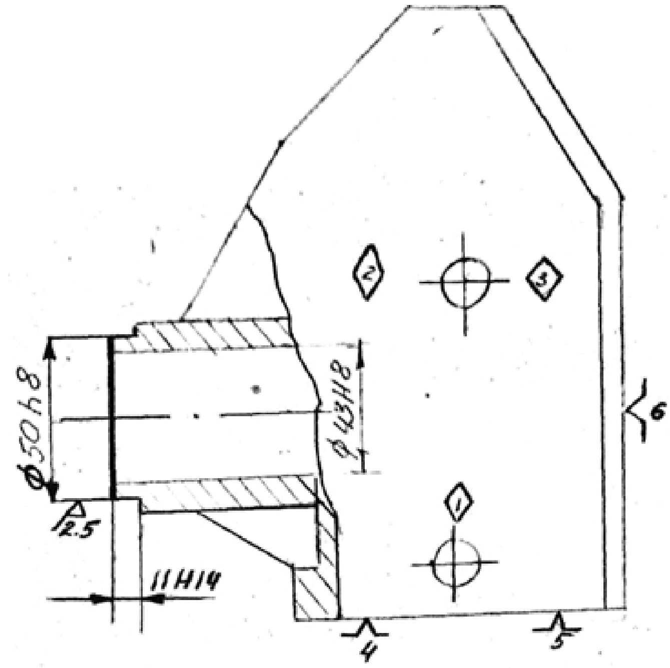

Table 3.8 – calculation of allowances and size limits on technological transitions in surface treatment ∅50 h8 housing

technological transitions in surface treatment ∅50 h8.	Elements allowance			Estimated $2z_{min}$mcm	Estimated size dp, мм	allowance δmcm	The maximum size мм		Threshold allowance mcm	
	Rz	T	ρ				d min мм	d max мм	$2z_{min}^{pr}$	$2z_{max}^{pr}$
Preparation	160		1710		51,780	430	52,781	53,281		
Turning Previous	50	50	463	2,780	51,535	160	51,535	51,695	1574	1695

Turning final	30	30	308	2,623	49,961	30	49,961	50	1246	1586

The total value of spatial variations Logging determined by the formula

$$\rho = \sqrt{\delta_в^2 + \rho_в^2} = \sqrt{0,43^2 + 7,7^2} = 7710 \text{ mcm.}$$

ρz = ΔKB = 0.7 x 11 = 7.7mm.

δV = = ρsm 430mkm. = 0,43mm.

The final spatial deviation after the previous turning P1 = 0.06

x ρ = 0,06 x 77.10 = 462,6mkm.

After the final grinding

ρ1 = 0.04 x ρ = 0,04 x 77.10 = 308,4mkm.

Calculation of allowances held minirysnyh values using the basic formula

$2z_{min} = 2 (R2_{Z-1} + T_{I-1} + \rho_{I-1})$;

Minirysnyy allowance under the previous grinding

$2z_{min}$ 2 = (100 + 7710) = 27870mkm .;

During the final grinding

2zmin 2 = (160 + 463) = 2×623mkm .;

Thus we have calculated (drawing) the amount of 49.961 mm. other passages have

dp2 = 49,961 + 1.574 = 57.535mm .;

dp1 = 51,535 + 1.246 = 52.781mm .;

Most define the size limits for admission to the addition of rounded, smallest size limit

d_{max2} == 49.961+0.039 = 50мм.;

d_{max1} == 51,535+0.160 = 51,695мм.;

d_{max3} == 52,781+0.5 = 53,281мм.;

Threshold allowances Z_{max}^{pr} defined as the largest difference Z_{min}^{pr} and size limits - as the difference between the size limits of previous and executed transitions

$$2Z_{max1}^{pr} = 51,965\text{-}50 = 1,965 \text{ мм.};$$

$$2Z_{max2}^{pr} = 53,535\text{-}51,695 = 1,586\text{мм.};$$

$$2Z_{min1}^{pr} = 51,535\text{-}49,961 = 1,574\text{мм.};$$

$$2Z_{min2}^{pr} = 52,781\text{-}51,395 = 1,246\text{мм.};$$

We provide validation of the calculations

$$Z_{max2}^{pr} - Z_{min2}^{pr} = 1586\text{-}1246 = 340\text{mcm.};$$

$$\delta1 - \delta2 = 500\text{-}100 = 400\text{mcm.};$$

$$Z_{max1}^{pr} - Z_{min1}^{pr} = 1695\text{-}1574 = 121\text{mcm.};$$

$$\delta1 - \delta2 = 160\text{-}39 = 121\text{mcm.};$$

All calculation results are listed in the table. 2.4 Based on calculations of building layout allowances and tolerances on processing ∅50 H8. Fig. 2.4

On the other workpiece allowances and tolerances to choose table (GOST 21-76-77) and put down their values on the drawing blanks.

3.6 Selecting equipment

Machining hold on the area body parts machine shop. Metal cutting machines placed on the types of equipment that create a station of similar machines. The sequence of operations of the process plant to achieve the specified accuracy is correct.

Processing components implemented on the universal stall or stalls, as production is serial in nature. However, factory mechanical process has drawbacks:

- The degree of concentration of operations low.
- Significant costs of moving parts of the machine to machine.

Given these factors is proposed milling planes, ie preparation of technological bases lead to Vertical Milling machines VF - 57. The following operations bore, drilling, countersinking facets, milling grooves, protrusions planes perform at the processing center MR - 320. What has the following design features:

• By computing an automated change with full details of the cleaning of chips and dirt into the working area of the machine;

• automatic withdrawal and cleaning of chips from the cutting area;

• All of isolating the working of the machine, providing the most possible improved conditions of service.

The only type of work performed manually, is the establishment and consolidation of the workpiece.

For threading h0,75-6N M45, M42 h0,75-6N, M33 h0,75-6N, these bore holes for threading, bore bevels and grooves b = 1,9H 14 (0.25) (as drawing details) use the machine as treating 1k62 centre cannot perform these operations (due to material details) leading to the creation of the workpiece.

For cutting groove M3 - 6H; M4 - 6H; M2 - 6H; M2,5 - 6H using special vertical boring machine and MN 56

3.7 Selection tool

The choice of cutting tools used for software-defined transaction following combined factors:

1. Processing is performed without holes conductor sleeves and other devices for guiding tool.

2. The share of total time cutting operating time increases to 45-75% instead of 20% on conventional machines, which reduces resistance and increases its instrument separation.

3. Details of the handle on the principle of automatic reception Asked sizes.

Given the conditions mentioned operation plane annular face and annular cutters. For fixing use cartridges with zinc clamp, milling performed at moderate regimes determined drive power machine. When drilling holes ∅3; 2.5; 2.05; 1.6 using standard drill with a precise geometrical parameter, previously holding jumper sharpening drills spiral, thus providing better alignment with its work. The rising cost of drills offset the rising cost and improves the quality of parts.

Given that the specific surface treatment can only be done consistently in order to save time, concentrating elementary transitions using a combination of tools.

(Countersink drill for drilling and countersinking ∅2,5 trim, special drill, countersink holes for drilling and countersinking chamfer ∅9 ∅16) When boring holes ∅31,3 h10, ∅26,3 h10, ∅31 +0,2 use cutter "mikrotor" with precision settings to 0,001mm. Cutter adjustments carried out on the size of machine.

Table 3.7 - Selection cutting tool

№	operation	Transition	processing tool
1.	Routers	P_1	ultimate Cutter ∅ 50
2.	Lathe	$P_{1\text{-}2}$	Cutter checkpoints persistent 2103-0017 VK 6 GOST 18879-83
		$P_{3\text{-}4}$	Cutter boring stopping 2141-0005 VK
		P_5	Cutter groove
		$П_6$	Thread cutter 2662-0501 GOST 18876-83
		$П_{7\text{-}8}$	cutter pass 2102-0004 VK 6 GOS 18877-83
		$П_9$	Thread cutter 2662-0501 GOST 18876-63
3.	threading	$П_{1\text{-}2}$	Tap M3H3 2620-1013 GOST 3266-81
		$П_3$	Tap M4H3 2620-1091 GOST 3266-81
		$П_4$	Tap M3H3 2620-1031 GOST 3266-81
		$П_{5\text{-}6}$	Tap M2H3 2620-1061 GOST 3266-81
		$П_{7\text{-}11}$	Tap M3H3 2620-1013 GOST 3266-81
		$П_{12}$	Tap M2,5H3 2620-1045 GOST 3266-81

3.8 Calculation of cutting

Operation routers

n - lytnyk process together with the main surface of the casting.

u - end cutter Ø50 2223-1057 GOST 16225-80. Submission of a tooth ρ_z = 0.14 mm / tooth (3, Tab. 35).

cutting speed $$V = \frac{C_v \cdot D}{T^m \cdot t^x \cdot S_2^z \cdot B^u \cdot Z^p} \cdot K_v$$; м/min

where Kv - joint correction factor that takes into account cutting conditions.

$$Kv = K_{m\delta} \cdot K_{n\delta} \cdot K_{nv};$$

Kmδ - factor that takes into account the quality of the material;

Kmδ = 0.8 [3, Table 4];

Knδ - coefficient taking into account the state of the workpiece;

Knδ = 1.0 [3, Tab. 5];

Then

$$Kv = 0.8 \times 0.9 \times 1.0 = 0.72;$$

T = period of stability 120hv. [3 Table. 40];

CV = 185.5;

g = 0,45;

x = 0.3;

y = 0,2;

u = 0,1;

p = 0.1;

m = 0,33.

$$V = \frac{185 \cdot 50^{0,45}}{120^{0,33} \cdot 50^{0,3} \cdot 0{,}14^{0,2} \cdot 0{,}3^{0,1} \cdot 6^{0,1}} \cdot 1 = 153{,}5$$

.

The spindle speed:

$$m = 1000 \times \upsilon/\pi \times D = 1000 \times 153{,}5/3{,}14 \times 50 = 977{,}7 min^{-1};$$

Accepted spindle speed on the machine standard:

$n_{pr}=1000 min^{-1}$ When:

$$V=\pi Dh/1000=3.14 \times 50 \times 1000/1000=150\ ^{м}/_{min};$$

Power cut:

$$P_z = \frac{10 \cdot C_p \cdot t^d \cdot S^z \cdot B^u \cdot Z}{D^g \cdot U^w} \cdot K_{mr};$$

where K_{mr} - correction factor for the quality of the material; K_{mr} = 1.0 [3, 10, S265].

C_p = 22.6;

j=0,86;

g=0,86;

u=1,0;

y=0,72;

w=0 [3, T, 41].

Pz=113,28N

Table 3.8 - Components of power supply

Horizontal power supply	Pn x Pz	0,4
Vertical	Pv x Pz	095
Radial	Py x Pz	0,4
Axial	Pv x Pz	0,5

Torque on the spindle:

M_{Kr} = Rz x D / 2 x 100 = 113.28 x 50/2 x 100 = 28.32N;

Power cut:

Ne = Pz x V / 1020 x 60 = 110.28 x 150/1020 x 60 = 0.285kVt;

Operation lathe:

n - Undercut end withstand the amount of 160,5 ± 0,6, Rz 40

u - Cutter checkpoints persistent VK6 GOST 188 79-73

Lrh Lriz = x + ut Ldop = 160.5 + 5 = 165,5mm.

Depth of cut t = 1 mm. Supply S = 0,7 mm / rev (4, C225)

Cutting speed:

$$V = (Cv / Tm \times tk \times \delta y) \times Kv, m / min;$$

T - Average tool life.

At the same instrumental treatment of T - 50 min

Kv - the product of factors allowing for the workpiece material, tool material.

$$Kv = 0.8 \cdot 0.9 \cdot 2.7 = 1.94;$$

CV = 328;

x = 0.12;

y = 0.5;

m = 0,28 [3, 17 T S270].

Then V = 254m / min

The frequency spindle:

$$n = 1{,}000 \times V / \pi D = 1000 \times 254/160 \times 3.14 = 505 min^{-1};$$

Take standard value

$n_{pr} = 500 min^{-1}$;

Then $V_{pr} = \pi dn / 1000 = 3.14 \times 160 \times 500/1000 = 251$ m / min;

Power cut

$$Rz = 10Cp \cdot t_x \cdot S_y \cdot V_n \cdot k_p,$$

where

t - 15 the length of the cutting tool.

K_p - correction factor, the product of a number of factors, given the actual conditions of cutting.

$K_{mr} = 1.5$;

$K_{ur} = 0.89$;

$K_{jr} = 1$;

$K_{zr} = 1$;

$K_{kr} = 1$ [3t 9, S264];

$$Kp = 1.5 \cdot 0.89 \cdot 1 \cdot 1 \cdot 1^2 = 1.34;$$

$C_p = 40$;

$x = 1.0$;

$y = 0.75$;

$n = 0$. [3t.22 S274];

Then

$Rz = 10 \cdot 40 \cdot 15^1 \cdot 0{,}7^{0{,}75} \cdot 251^0 \cdot 1{,}34 = 4904$ N;

Power cut:

$N = Rz \cdot V / 1020 \cdot 60 = 4904 \cdot 251 \; /1020 \cdot 60 \; = 6.29$kVt

Q2: TO sharpen outer surface to ø50N8 (-0.046) with end trimming under 11N14 x 0,043 25v after requirements according to the drawing.

u - Cutter checkpoints persistent R18 GOST 18879-13.

The length of the working stroke:

$$L_{rx}=L_{cut} + y + L_{dop}=11+4=15min;$$

Accepted depth of cut t = 1, feed δ = 0,55mm / v (3, T11, S266)

cutting speed

$$V=Cv/(T^m \text{ x } t^x \text{ x } \delta^v \text{ x } K^v) \; ^{м}/_{min}$$

Average tool life T = 50min.

Kv - the product of the coefficients given the workpiece material, the state of the surface material of the tool:

$$K_v=K_{mv} \text{ x } K_{\eta v} \text{ x } K_{nv}=0.8 \text{ x } 0.9 \text{ x } 2.7=1.94;$$

Factor taking into account the actual cutting conditions

Cv = 328;

K = 0.12;

y = 0.5;

m = 0.28 [3 T17, S270];

Then V = 107m / min;

Actual spindle speed:

$m = 1000 \text{ x } V / \pi d = 1000 \text{ x } 107 / 3.14 \text{ x } 50 = 681 min^{-1}$;

standard value on the machine

n_{pr}=800min^{-1};

Then

Vpr = πDch / 1000 = 3.14 x 50 x 800/1000 = 126 m / min;

Power cut

$$P_z=10Cp\cdot t^x\cdot J^y\cdot V^n\cdot K_p;$$

where Kp - correction factor, Kp = 0.89;

Factor, given the conditions of cutting.

Cp=40;

x=1;

y=0,75;

n=0. [3, T.22 C274];

Then cutting force

$$Pz=10\cdot 40\cdot 15^1\cdot 0{,}55^{0{,}75}\cdot 126^0\cdot 0{,}89=3232\ N;$$

Power cut:

$$N=Pz\cdot V/1020\cdot 60=3232\cdot 126/1020\cdot 60=7{,}8\text{кWt};$$

Undercut end size 11H14

Takes depth of cut t = 0,5 mm. supply and ρ = 0,7mm / rev [3, T11, S266];

The length of the working stroke:

$$L_{px}=(50-43/2)+2=5{,}5\text{мм.};$$

cutting speed

$$V=Cv/(T^m\ x\ t^x\ x\ \delta^v\ x\ K^v)\ ^{м}/_{min};$$

multiplication factors allowing for the workpiece material, tool material.

K_v = 1.94;

Factor taking into account the actual cutting conditions

C_v = 328;

K = 0.12;

y = 0.5;

m = 0.28 [3 KZT17, S270]

Then V = 107m / min

$$m=1000 \times V/\pi d=1000 \times 107/3.14 \times 50=681 min^{-1}$$

Standard value on the machine

$n_{pr}=800min^{-1}$

Then

$$V_{пр}=\pi Dch/1000=3.14 \times 50 \times 800/1000=126\ ^{м}/_{min};$$

Power cut $P_z=10Cp \times t^x \times J^y \times V^n \times K_p$, where

K_p - correction factor, $K_p = 0.89$

Factor, given the conditions of cutting

Cp=40;

x=1;

y=0,75;

n=0.

Then cutting force

$$Pz=10\cdot 40\cdot 15^1\cdot 0,55^{0,75}\cdot 126^0\cdot 0,89=3232\ N;$$

Power cut:

$$N=Pz\cdot V/1020\cdot 60=3232\cdot 126/1020\cdot 60=7,8KW;$$

Q3: bore surface hole ø$41,23^{+0,15}$ x M42 thread at 0,75-6H

u - Cutter boring stopping y = 95; VK6 GOST 18883-83.

Takes depth of cut t = 0.5 mm., The supply of ρ = 0.3 mm / rev (3, T11, S266)

The length of the working stroke:

$$L_{px}=L_p + y=17+2=19мм.;$$

The average value of stability in one instrumental treatment of T = 50min.

cutting speed

$$V=V_{tab}\cdot K_1\cdot K_2\cdot K_3;$$

At

T = 50min

$K_2 = 1.2$

$K_3 = 0.35$ [4, C33];

Then

$$V=197^{м}/_{min}\ V_{tab}=190\ ^{м}/_{min};$$

Actual spindle speed:

$$n=1000\ x\ V/\pi d=1000\ x\ 197/3.14\ x\ 41=1129min^{-1};$$

Standard spindle speed on machine

n_{pr}=1250min^{-1}

$$\text{Then } V_{pr}=\pi D\eta/1000=3.14\ x\ 41\ x\ 1250/1000=161\ ^{м}/_{min};$$

Power cut

$$P_z=10C_p\cdot t^x\cdot \delta^y\cdot V^n\cdot K_p;$$

where

Kp - correction factor, Kp = 0.89;

Factor, given the conditions of cutting.

Cp = 40;

x = 1;

y = 0.75;

n = 0. [3, T.22 S274].

Then cutting force

$$Pz=10\cdot 40\cdot 15^1\cdot 0{,}3^{0{,}75}\cdot 161^0\cdot 0{,}89=3232\ N;$$

Power cut:

$$N=Pz\cdot V/1020\cdot 60=3232\cdot 126/1020\cdot 60=10KW;$$

Q3: bore holes ø43N8 end of the trimming size 48H14

u - Cutter boring stopping at y= 95^0; VK6 GOST 18883-83.

Takes depth of cut t = 1 mm., Filing ρ = 0.3 mm / rev (3, T11, S266)

The length of the working stroke:

$$L_{px}=L_p + y=48+2=50мм.;$$

The average value of stability in one instrumental treatment of T = 50min.

cutting speed

$$V=V_{tab}\cdot K_1\cdot K_2\ ^{м}/_{min};$$

At T = 50min

K_1 = 1,2

K_2 = 0.85 [4, C33];

Then

$$V=197^{м}/_{min}\ V_{tab}=190\ ^{м}/_{min};$$

Actual spindle speed:

$$m=1000 \cdot V/\pi d=1000 \cdot 197/3.14 \cdot 43=1114min^{-1};$$

Standard spindle speed on machine

$u=1250min^{-1}$;

Then $V_{pr}=160\ ^{м}/_{min}$;

Power cut

$$P_z=10C_p \text{ x } t^x \text{ x } S^y \text{ x } V^n \text{ x } К_p,$$

Kr - correction factor

Kr = 0.89;

Factor, given the conditions of cutting.

W = 40;

x = 1;

y = 0.75;

n = 0. [3, T.22 S274];

Then cutting force

$$Pz=10 \cdot 40 \text{ x } 15^1 \text{ x } 0,3^{0,75} \text{ x } 161^0 \text{ x } 0,89=3232 \text{ N};$$

Power cut:

$$N=Pz \text{ x } V/1020 \text{ x } 60=3232 \text{ x } 160/1020 \text{ x } 60=10.01KWt;$$

P5: Bore groove in = 1,9H14 to Ø45, 3H14 following sizes 27H14, chamfer 0,6 ± 0,2 x 45^0.

Accepted depth of cut t = 1,15mm. And supply ρ = 0,08mm / rev (4, C25)

The length of the working stroke:

$$L_{px}=1,9+4=5,9мм.;$$

cutting speed

$V = V_{tab}$ x K_1 x K_2 x K_3 = 225 x 1.1 x 0.85 = 210 m / min

K_1 - coefficient dependent;

K_2 - coefficient allowing for

The spindle speed:

n = 1000 x V / πd = 1000 x 210 / 3.14 x 50 = 1478 min^{-1}

Accepted standard value for the machine

n_{pr} = 1600 min^{-1}

Then V_{pr} = πDη / 1000 = 3.14 x 45,3 x 1600/1000 = 228 m / min

Power cut $R_z = R_{zTab}$ x K1 x K2 = 33 x 0.3 x 0.9 = 8,91N

where R_{ztab} = 33k

K1 - coefficient depending on the material;

K_2- coefficient dependent on the cutting speed

K_r - correction factor, K_r = 0.89

Power cut

$$N=Pz \cdot V/1020 \cdot 60=8,91 \cdot 228/1020 \cdot 60=1.03KWt;$$

P7: Bore hole ø44,23 + 0.15 during thread M 45 x 0,75-6N before entering the groove.

u - cutter boring stopping VK6 2141-0005 GOST 18883-83. φ = 950

The length of the working stroke:

$$L_{rx} = L_{rez} = + \delta = 25,1 + 3 = 28,1mm .;$$

Takes depth of cut t = 0.5 mm., The supply of δ = 0.3 mm / rev [3, T11, S266];

cutting speed

$$V=V_{Tab} \cdot K_1 \cdot K_2 \cdot K_3 \ ^{M}/_{min};$$

The average value of stability in one instrumental treatment of T = 50min.

Therefore, given the conditions of cutting rates, K_2 = 1.1 K_z = 0.85 [4, C33];

Then

$$V=190 \cdot 1,1 \cdot 0,85=178 ^{M}/_{min};$$

Actual spindle speed:

$$n=1000 \cdot V/\pi d=1000 \cdot 178/3.14 \cdot 45=1257min^{-1};$$

Standard spimdle speed value n_{pr}=1250min^{-1};

Then

$$V_{pr}=\pi DA/1000=3.14\cdot 95\cdot 1250/1000=177\ ^{м}/_{min};$$

Power cut

$$P_t=10\cdot C_r\cdot t^x\cdot S^y\cdot V^n\cdot K_{гт};$$

K_p - correction factor, K_p = 0.89;

Factor, given the conditions of cutting.

C_r = 40;

x = 1;

y = 0.75;

n = 0. [3, T.22 S274];

Then cutting force

$$R_z=10\cdot 40\cdot 15^1\cdot 0{,}3^{0{,}75}\cdot 177^0\cdot 0{,}89=3232\ N;$$

Power cut:

$$N=R_z\ x\ V/1020\ x\ 60=3232\ x\ 177/1020\ x\ 60=11KWt;$$

Q9: Cut thread M45 x 0,756.

u – Thread cutter 2662-0,501 GOST 18876-83.

The length of the working stroke:

$$L_{px}=L_{cut}+y=1263\text{-}15мм.;$$

Accepted supply equal pitch ρ=0,75$^{мм}/_{rev}$

cutting speed

$$V=C_v\cdot i^x/(T^m\ x\ \rho^y)\ x\ K\rho\ ^{м}/_{хв};$$

where T - the average tool life T = 50min. Factor taking into account cutting conditions:

Cv=328;

x=0,12;

y=0,5;

m=0,28.

i - the number of moves,i = 6

$К_v$=1.3 [4, C162];

$К_v$ – rate dependent material.Then V=204$^м/_{min}$;

Actual spindle speed:

$$u=1000\cdot V/\pi d=1000\cdot 204/3.14\cdot 42=1546 min^{-1};$$

Standard spindle speed for machine n=1600min^{-1}

Then

$$V_{pr}=\pi D\varphi/1000=3.14\cdot 42\cdot 1600/1000=211\ ^м/_{min};$$

Сила різання

$$R_z=(10C_p\cdot P^y/J^n)\ x\ К_p;$$

$К_p$ – correction factor Kp =1.33;

Factors, given the conditions of cutting.

Cp=40;

n=0;

y=0,75; [3T.22 C274];

$$R_z=(10\cdot 40\cdot 0.75^{0,75}/6)\cdot 1.33=430\ N;$$

Power cut:

$$N=R_z\cdot V/1020\cdot 60=430\cdot 211/1020\cdot 60=0.48KWt;$$

Q10: Cut thread M45 x 0,75-6H.

u – Thread cutter GOST 18876-83. 2662-0,501

The length of the working stroke:

$$L_{px}=L_{cut}+y=25+6=31мм.;$$

Accepted supply equal pitch ρ=0,75$^{мм}/_{rev}$

cutting speed

$V=C_v\cdot i^x/(T^m\cdot S^y)\cdot Кv$, $^м/_{min}$;

where T - the average tool life T = 50min.

Factor taking into account cutting conditions:

Cv=328;

x=0,12;

$y=0,5$;

$m=0,28$. [3, T.17 C270];

i – number of working strokes, i = 6 [3, T.46 C297].

K_v – rate dependent material.

$K_v=1.3$ [4, C162];

Standard spindle speed value for machine $n=1600min^{-1}$

Then

$$V_{pr}=\pi D\varphi/1000=3.14\cdot 50\cdot 1600/1000=226\ ^{м}/_{min};$$

Power cut

$$R_z=(10C_p \text{ x } P^y/J^n) \text{ x } K_p;$$

K_p – Correction factor, Kp =1.33.

Factors, given the conditions of cutting.Cp=40;

$n=0$;

$y=0,75$. [3T.22 C274].

$$Rz=(10\cdot 40\cdot 0.75^{0,75}/6)\cdot 1.33=430 \text{ N};$$

Power Cut

$$N=R_z\cdot V/1020\cdot 60=430\cdot 226/1020\cdot 60=0.60KW$$

P11: boring operation.

Accepted supply equal pitch $\rho=1^{мм}/_{rev}$

cutting speed

$$V=C_v\cdot D^g/(T^m\cdot \rho^y)\cdot Kv,\ ^{м}/_{min};$$

where T - the average tool life T = 80min. Factor taking into account cutting conditions:

Cv=20;

$y=0,5$;

$m=0,9$;

$g=1.2$. [3, T.50 C298];

Then $V=3.57^{м}/_{min}$

Actual spindle speed:

$$u=1000\cdot V/\pi d=1000\cdot 3.57/3.14\cdot 3=3196 min^{-1};$$

standard value is given to the machine $u=355min^{-1}$;

Then

$$V_{pr}=\pi Dn/1000=3.14\cdot 3\cdot 355/1000=3.34\ ^{м}/_{min};$$

Determine the torque

$$M_{кр}=10C_{м}\ Dg\rho^{4}Kp;$$

$К_{р}$ –correction factor,Kp =1.04

Coefficient

Cm=0.0022;

g=1.8;

y=1.5; [3T.51 C298];

Then

$$M_{кг}=0,159\ Nm;$$

Power cut:

$$N=Mn/975=0.159\cdot 355/975=79KW;$$

P13: Cut thread M4 - 6H. Through a 3-hole (note the entrance to the plane)

U- Tap M4H3 2620-1091 GOST 3266-81

Accepted supply equal pitch $\rho=1^{мм}/_{rev}$

cutting speed

$$V=C_{v}\cdot D^{g}/(T^{m}\cdot\rho^{y})\cdot Кv,\ ^{м}/_{min};$$

where T - the average tool life T = 90 min. Factor taking into account cutting conditions:

Cv=20;

y=0,5;

m=0,9;

g=1.2. [3, T.50 C298];

Then $V=5.04^{м}/_{min}$

The spindle speed:

$$n=1000\cdot V/\pi D=1000\cdot 5.04/3.14\cdot 4=401 min^{-1};$$

Standard value n_{pr}=500min^{-1}

Then

$$V_{pr}=\pi Dn/1000=3.14\cdot 4\cdot 500/1000=6,02\ ^{м}/_{min};$$

Determine the torque

$$M_{кр}=10C_{м}\ Dg\rho^{4}Kp;$$

K_p - correction factor K_p =1

Coefficient.

Cm=0.0022;

g=1.8;

y=1.5; [3T.51 C298];

Then

$$M_{кр}=0,227\ Nm$$

Power cut:

$$N=Mn/975=0.227\cdot 500/975=0,109KW;$$

P5: Cut thread M2-6H. At a depth of $4.5^{+1.5}$ 3 holes (season of the emergence B-E)

u – Tap M2H3 1620-1013 GOST 3266-81

The length of the working stroke:

$$L_{rx}=4,5+6=10,5мм.$$

Accepted supply equal pitch $\rho=1^{мм}/_{об}$

cutting speed

$$V=C_{v}\cdot D^{g}/(T^{m}\cdot\delta^{y})\cdot Kv,\ ^{м}/_{хв};$$

where T - the average tool life T = 90 min. Factor taking into account cutting conditions:

Cv=20;

y=0,5;

m=0,9;

g=1.2. [3, T.50 C298];

Then V=2,19$^{м}/_{min}$

Spindle speed:

$$u=1000\cdot V/\pi D=1000\cdot 2.19/3.14\cdot 2=349 min^{-1};$$

Standard spindle speed value n_{pr}=355min^{-1}

$$D_{пр}=\pi Dn/1000=3.14\cdot 2\cdot 355/1000=2.51\ ^{м}/_{min};$$

Determine the torque

$$M_{кр}=10C_{м}\ Dg\rho^{4}K_{p};$$

K_p – coefficient factor, K_p =1;

Coefficient.

Cm=0.0022;

g=1.5;

y=1.5; [3T.51 C298];

Then

$$M_{кг}=0,076\ Nm$$

Power cut:

$$N=Mn/975=0.076\cdot 355/975=31.4KW;$$

Q12: Cut thread M2.5-6N. The depth 5 + 1.5 4 holes (see tons).

u – Tap M25H3 2620-1045 GOST 3266-81

The length of the working stroke:

$$L_{rx}=5+6=11мм.$$

Accepted supply equal pitch ρ=1$^{мм}/_{rev}$

cutting speed

$$V=Cv\ x\ D^{g}/(T^{m}\ x\ \delta^{y})\ x\ Kv,\ ^{м}/_{min}$$

where T - the average tool life T = 90 min. Factor taking into account cutting conditions

Cv=20;

y=0,5;

m=0,9;

g=1.2. (3, T.50 C298)

Then $V=2{,}87^{м}/_{min}$

The frequency spindle:

$$u=1000 \text{ x } V/\pi D=1000 \text{ x } 2.87/3.14 \text{ x } 2{,}5=365min^{-1}$$

Standard spindle speed value $n_{pr}=355min^{-1}$

Then

$$V_{pr}=\pi Dn/1000=3.14\cdot 2.5\cdot 355/1000=2.5\ ^{м}/_{min};$$

Determine the torque

$$M_{кр}=10C_{м}\ Dg\rho^{4}\cdot Kp;$$

K_p – correction factor, $K_p=1$;

Coefficient.

Cm=0.0022;

g=1.8;

y=1.5; [3T.51 C298];

Then

$$M_{кг}=0{,}075\ N\cdot м;$$

Power cut:

$$N=Mn/975=0.075\cdot 355/975=30.9KW;$$

Operation milling machines - Boring

1	2	3	4	5	6	7	8
№	name of transition	processing tool	V_1 м/ min	Мк/ rev	t_1 mm	n_1 min^{-1}	T_o min
1.	Mill following box sizes 64H12x42H12x62H1 2	ultimate Cutter P6M5 GOST 20538-85 (D=8, Z=2)	103	478	6	1797	1,9 2
2.	Milled surface 1 following sizes 161±0,2	Mill End mounted with a fine tooth P6M5, D=63, Z=161 GOST 9301-85	120	48,3	1,1 4	2148	2,0 5
3.	Drill holes ⊘ $2,5^{+0,1}$	Drill-specific drills 8=M5	41,5	0,03	1,6 5	4000	0,9 6
4.	Bore ⊘ 26,3H9 with roughness ^{2,5}d	Boring cutter P6M5 GOST 91-95-83	65	129	0,6	962	0,0 43
5.	Boring hole ⊘ 31,3H9 with Roughness ^{2,5}d	Boring cutter P6M5 GOST 9195-83	87	129	8,6	962	0,0 56
6.	Milled surface floor size in 124±0,2; 8H14; 19H12; 40H49	ultimate Cutter P6M5 ГОСТ 20538-85 (D=8, C=2)	110	659	1,1	2148	0,6 2
7.	Drill 2 holes ⊘$2,5^{+0,1}$ x $6^{1,5}$	Drill-specific drills P6M5	41,5	0,08	7	4000	0,3 2
8.	Maintaining milled groove dimensions 7H14; 12H14	ultimate Cutter P6M5 GOST 10523-85 (D=7, Z=2)	110	659	1.1 4	2148	0.4 9
9.	Drill 2 holes ⊘$2,5^{+0,1}$	Drill-specific drills P6M5	41.5	0.03	1.6 5	4000	1.9 2

10.	Milled surface following sizes 87±0,5 roughness R_z20	End mill D=100, Z=14 GOST 9804-85	120	659	4	2143	0.0 2
11.	Drill hole ⊘9H9 with drawing chamfer ⊘16x9	Drill-specific drills P6M5	39,2	0,08	1,8 2	4000	0,5 2
12.	Drill 5 holes ⊘$1,5^{+0,2}$	Drill-specific drills P6M5	40,02	0,03	1,6 5	4000	0,4 8
13.	Boring holes ⊘$31^{+0,2}$, до ⊘$32,2^{+0,17}$ by thread M25x0,75 6H	Boring cutter P6M5 GOST 9195-83	87	129	0,6	962	0,0 8
14.	End mill following the thread 38,5H12	End mill P6M5, D=63, Z=14 ГОСТ 9304-85	120	483	1,1	2143	0,3 1
15.	Mill performance following 0,5 step 20±0,2; roughness^{2,5}d	ultimate Cutter P6M5 GOST 20538-85 (D=16, Z=3)	135	483	2	2148	0,6 4
16.	Drill 8 holes ⊘$2,5^{+0,1}$ до $7^{+1,5}$	Drill-specific drills P6M5	41,5	0,03	8	4000	1,2 8
17.	Drill 4 holes ⊘$2,5^{+0,1}$	Drill-specific drills P6M5	41,5	0,03	1,6 5	4000	0,6 3
18.	Milled surface following sizes 60H14, R_z=40	ultimate Cutter P6M5 GOST 9304-85 (D=63, Z=14)	110	483	4	2148	0,3 1
19.	Milled surface following sizes 8,8H12, $49^{\pm0,35}$; $50^{\pm0,85}$	ultimate Cutter P6M5 ГОСТ 20538-85 (D=16, Z=3)	108	478	6	1797	0,5 6
20.	Drill holes ⊘$2,5^{+0,1}$ X $6^{+1,5}$	Drill-specific drills P6M5	41,5	0,03	8	4000	1,2 8

21.	Mill following box sizes R14 46H12, 110H12	ultimate Cutter P6M5 ГОСТ 17026-81(D=28, Z=5)	108	478	2	1797	0,69
22.	Mill following box sizes R20 40H12, 104H12	ultimate Cutter P6M5 ГОСТ 17026-81(D=40, Z=6)	108	478	1,4	1797	0,75
23.	Drill 4 holes ⌀2,05 X $5^{+1,5}$	Drill-specific drills P6M5	41,5	0,03	1,65	4000	0,92
24.	Drill 4 holes ⌀2,05 through	Drill-specific drills P6M5	41,5	0,03	1,63	4000	0,92
25.	Cut thread M23 x 0,75-6M	Special Tap	29,1	0,75	1,9	403	0,065

3.9 Calculation of technical rules of time

Technical standard time in terms of the type of production (medium serial) established settlement-analytical method.

Tм-к=Tn-z/n+Tмт

where:

T_{n-z} – preparatory-final time. (min).

U – the number of parts in the following set. (Unit).

$T_{unit}=T_o+T_v+T_{ob}+T_{ot}$;

where:

T_o – most of the time (min).

T_v – auxiliary time (min).

T_{ot} – a break to rest and personal needs. (min).

T_{ob} – service working hours. (min).

In general terms.

$T_{м-к}=T_{n-z}/n+T_o+(T_{uc}+T_{zo}+T_{up}+T_{chz})K+T_{ob}$;

K_1 – for mass production = 1,85.

The basic formula for a forward - turning at work:

To= Lrx./nδ min.

When working on thread-cutting machines:

$$T_o= L_{rx} ./ Sn; \text{min.}$$

T_{ot}, T_e T_{on}, T_{ob} - take in accordance with the regulations in time for mass production (2 S.214-221) and puts the results in the table. 2.7.

Technical standards in time for milling - drilling - boring operation count based on the works general time standards work performed for treating type farrowing facility.

Table 3.9 – Calculation of machining time

operation	То, хв.	Тв, хв.			Топ = То+ Тв хв	Тоб, хв.		Тот, хв	Тшт, хв	Тпз, хв	Тпк, хв
		Туc	Туп	Тмз		Ттех	Тор2				
Vertical milling.	1,36	0,1	0,04	0,16	1,66	1,9	0,02	0,04	3,63	1612	3,65
Milling-vertically rose.	20,07	1,65			22,22	0,56	0,63	0,56	21,6	27,07	22,88
Turning lathe.	10,01	0,54	0,072	0,84	11,952	3,4	0,23	0,78	16,3	26	9,36
Threading	7,68	0,26	0,015	0,39	8,345	1,7	0,79	0,19	11,02	6	11,03

1. Support time for installation and removal of parts

$$T_{us} = 0.13 + 0.21 = 0{,}34\text{min [16KI C24]};$$

2. Supporting time management easel

T_{uap} = 0.02 + 0.03 + 0.04 + 0.5 + 0.04 +0.27 = 0,9min [16 BB, C26];

3. preparatory-final time

T_{pz} = 2+3+3+2+0,3+2,0+0,67+0,4+0,7+5+3+7 = 27,07хв [К7 С32];

4. Auxiliary time.

T_{izm}=0,1+0,2+0,11=0,41 [16, К9, С33];

5. Auxiliary time

T_v=T_{uct}+T_{upr}+T_{im}=0,34+0,9+0,41=0,65 min.;

6. Operating time

T_{op} = T_{pr}+T_v+$К_{tz}$ min.;

Where the vehicle - correction factor for auxiliary time depending on the duration of treatment party details.

$К_{tz}$=1,3 [16, К9, С33];

Then

T_{op}=20,07+1,65·1,3=22,22min.

T_{unit}=T_{op} (1+L_{org}+L_{teh}+L_{otd}/100);

where

L_{org} – organizational service jobs L_{org}=4,5% (16, К6)

L_{teh} – maintenance jobs L_{teh}=4% (16, К6)

L_{otd} - rest and personal needs of the worker L_{otd}=4% (16, К6)

Then

T_{unit}=22,27·(1+0,56+0,56+0,63/100)=22,60min.

T_{unit}. Kal = T_{unit}+T_{pz}/p=22,6+27,4/95=22,885min

3.10 Description of the installation accessories. Installed accessories to angle

Brief description of devices. Basis adjustments during the installation of the machine 5 focuses pin 9 and 4 finger, in addition secured to two bolts.

Blanks dress ∅27 h14 in lock hole 3, the pin 11 and 2 finger cut.

Then press a set 1.

Used construction of high-speed position press - screw clamp 3 split folding bar.

Washer 10 installed on pin 11 clamped nut nuts 8. After weakening 8 (or strips) moves the puck 10 and the workpiece is removed through the nut 8 with a diameter smaller than the diameter of the hole in the workpiece.

3.11 Calculation of adjustments to the installation angle

Nominal screw diameter mm. where C = 1.4 coefficient for primary metric thread.

$$d = \varepsilon\sqrt{\frac{Q}{6}} \quad ;$$

Q - fixing strength of the workpiece, = 7166N.

6 - tensile stress (compression) for steel screws 45, taking into account depreciation of the thread. Q = 80 / 100MP

Then

$$d = 1{,}4\sqrt{\frac{7166}{100}} = 9{,}88mm$$

Diameter is rounded to the nearest whole value d = 10.

The resultant moment on the arm or flywheel, to produce a given force consolidation.

$$M=H_{sr}Qtg(\alpha+\rho)+M_{tr;}$$

H_{sr} - mean radius of the thread;

ρ - angle of friction in the thread;

α - angle of climb thread;

M_{tr} - moment of friction at the hardware end of the nut or screw.

$$M_{mp} = \frac{1}{3} \cdot f \cdot Q \cdot \frac{D_{м}^3 - d_{в}^3}{D_{м}^2 - d_d^2};$$

Taking α = $2^0 30'$ (for groove from M8 to M42 - used in adaptations α varies from

(3^0 10' to 1^0 57').

$f = 10^0 30'$, $H_{sr} = 0{,}45d$, $D_{м} = 1.7d$, $d_B = d$, $f = 0{,}15$.

We obtain an approximate formula for the moment on the basic side nuts.

$$M = 0.2d\ Q = 0.2 \cdot 9.85 \cdot 71.66 = 14 \text{KNmm}.$$

The moment of detachment screw with clamps

$$\rho > \alpha$$

$$M' = H_{sr} \cdot Q \cdot tg(\rho - \alpha) + M_{tr}$$

At the detachment have to overcome static friction and so the value of ρ and f and take 30-50% more than the consolidation.

After transformations, we obtain the approximate formula

$$M' = 0.25\alpha \cdot Q = 0.25 \cdot 9.85 \cdot 71.66 = 17 \text{KNmm}.$$

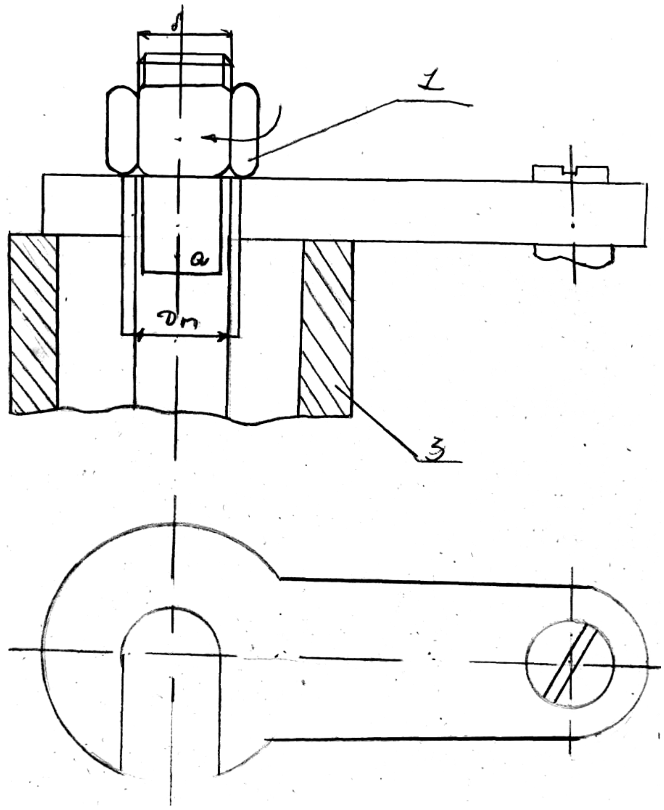

Figure 3.9 – high-speed screw clamp with hinged cutting bar

Determine the force securing the workpiece.

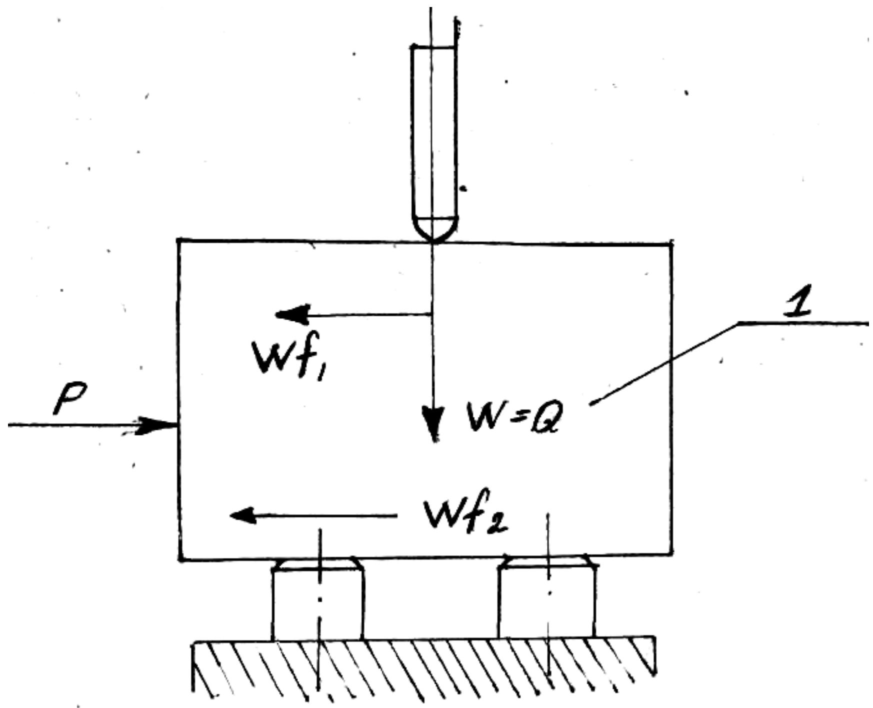

Figure 3.10 – Detailed scheme in adjustments

Power clamp the workpiece W and Rz Asked cutting force are acting on the workpiece in mutually perpendicular directions.

Cutting force counteracting force of friction between the bottom surface of the base reference plane parts and accessories, between the upper plane parts and tightening device.

Power cut piece is determined by the formula

$$W=KPz/f_1+f_2;$$

where f1 and f2 - friction.

K - coefficient of wear, which guarantees reliable fastening piece.

Rz - cutting force when routing Rz = 490 N.

Factor is determined by the formula

$$K=K_0 \cdot K_1 \cdot K_2 \cdot K_3 \cdot K_4 \cdot K_5 \cdot K_6,$$

where R0 - guaranteed reserve ratio; R0 = 1.5.

K1 - coefficient allowing for the growth of cutting forces through random inequalities; K1 = 1.

R2 - coefficient allowing for the growth of cutting forces, resulting blunt cutting tools; K2 = 1.2.

K3 - coefficient allowing for the growth of cutting forces, while intermittent cutting; K3 = 1.

K4 - coefficient describing constancy force consolidation; K4 = 1.3.

K5 - coefficient characterizing ergonomics.

K6 - factor taking into account the rotational moments (returning blank) [3, D.2, S.85].

Putting all the values in the formula, we get:

$$K=1,5 \cdot 1 \cdot 1,2 \cdot 1 \cdot 1,3 \cdot 1 \cdot 1,5=3,51;$$

Then the power of fixing piece consists of:

$$Q = W = \frac{3,51 \cdot 490}{0,12 + 0,12} = 7166,3N;$$

Determine the force F attached to the handle on the handle screw clamp.

$$F = W \cdot r_{cp} \cdot tg(\alpha + \varphi) + 0{,}33 \cdot f \cdot \frac{D_{м}^{3} - D_{в}^{3}}{D_{м}^{2} - D_{d}^{2}};$$

where l - length handles key mm.

r_{sr}- mean radius of the thread screw mm.

α - angle lifting screw thread $2^{0}\ {}_{1}30_{1}$

γ - given angle of friction in threaded couple $\gamma = 6^{0}\ 30^{1}$

f - coefficient of friction at the flat contact of two conjugated parts; f = 0,15.

r - the radius of the cylindrical portion of the lower end of the screw; mm.

D_{M} - outer diameter of the support end nut; mm.

D_{B} - inner diameter of the support end nut; mm.

D_{M} = 10.00mm., D_{B} = 8,376mm.

α_{sr} = 9.026

L = 250mm.

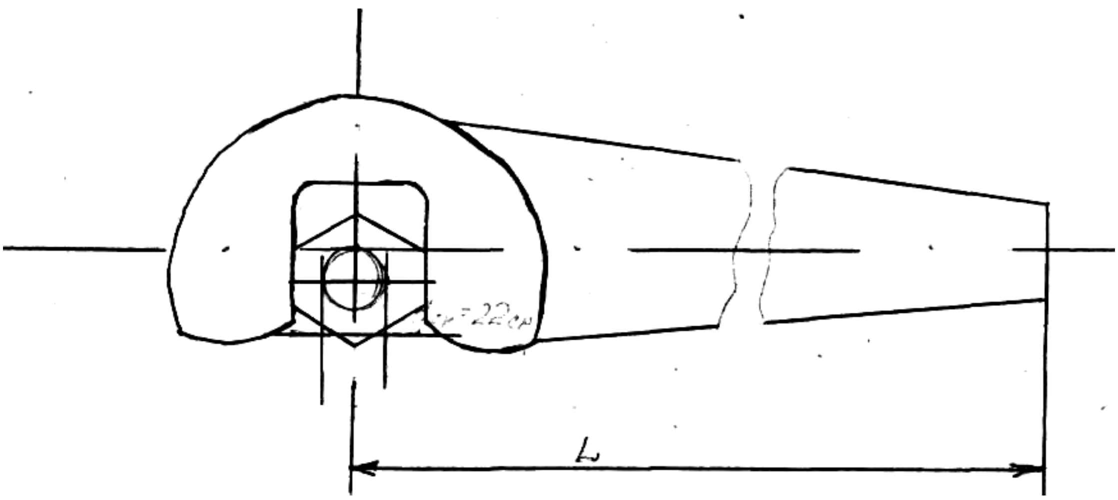

Figure 3.11 – Figure determining force of conception passed nut and key

Then the application of force F on the key:

F=7166,3 x 4,51tg x $(2^{0},30+6^{0}30)+0,33 \times 0,15 \times 10^{3} - 8,376^{3}/10^{2}-8,376^{2})\ /250 =$ *20,5*N;

Basing error when installing blanks on two works on two fingers adjusting (cylindrical and cut) occurs through cracks infinger joints and holes and is transferring angular displacement α workpiece.

Defining the largest possible angle transfer is made under the formula:

$$tg\alpha_{max}=(Smax_1+Smax_2)/2L;$$

Where Smax1, Smax2 major gap in the connection hole and a ring which has a connection, L - distance between the center (holes and fingers)

The data for calculating the angle of transfer determined directly from the drawing tools:

$$d_1 = 22mm \qquad D_1 = 27mm.$$

$$d_2 = 28mm \qquad D_2 = 31,3mm.$$

$$Smax_1=0.025mm.;\ Smax_2=0.069mm.$$

The distance between the centers of holes L = 126mm. Then transfer possible angle

$$tg\alpha_{max}=(\ Smax_1+\ Smax_2)/2L=(0.025+0.069/2\ x\ 126) = 0.037$$

$$\alpha_{max}=arctg\ 0.037$$

$$\alpha_{max}=2^0 13^1$$

In this basing cut finger should be placed so that its great diagonal is perpendicular to the line connecting the centers of the fingers.

Description of the installation devices

Case1. The installation of equipment mounted on the machine table by means of 3 holes ∅ 20mm. finger 3. The case 1 fixedly attached by two plate racks.

A plate is connected to the cross-piece 4 bolt pin 12 and 5, the construction of which will traverse 4 displaced vertically up a certain distance. Preparation installed two clamps 2, which traverse 4 lift up so that the blank wall came to capture close.

Then traverse 4 is released down the workpiece in the grip 9 stifle completely.

Calculation of the installation devices

In this adaptation pryminena clamp combination of threaded rod that acts as rychala and creating mechanism - freeze. Power clamp, called freeze Fig. 3.4.1. calculated by the formula:

$$F_{заж.} = Wa\eta/b;$$

where W - tightening force of screw or nut clamps.

a and b - freeze-size shoulders.

η - efficiency, allowing for friction losses in the bearings clamps.

η=0,8... 0,95.

To simplify and accelerate the calculation to determine the tightening mechanism forces use the table [21 C 13.1 Table 96].

When thread diameter α = 10mm. tightening force N = 2,9kn

a = 28 mm .; b = 45mm.

Then

$$F_{заж.}=2900\cdot 0,28\cdot 0,8/0,45=1444 \text{ N}.$$

Material hardness freeze steel 45 GOST1050-70 NRS 30-45

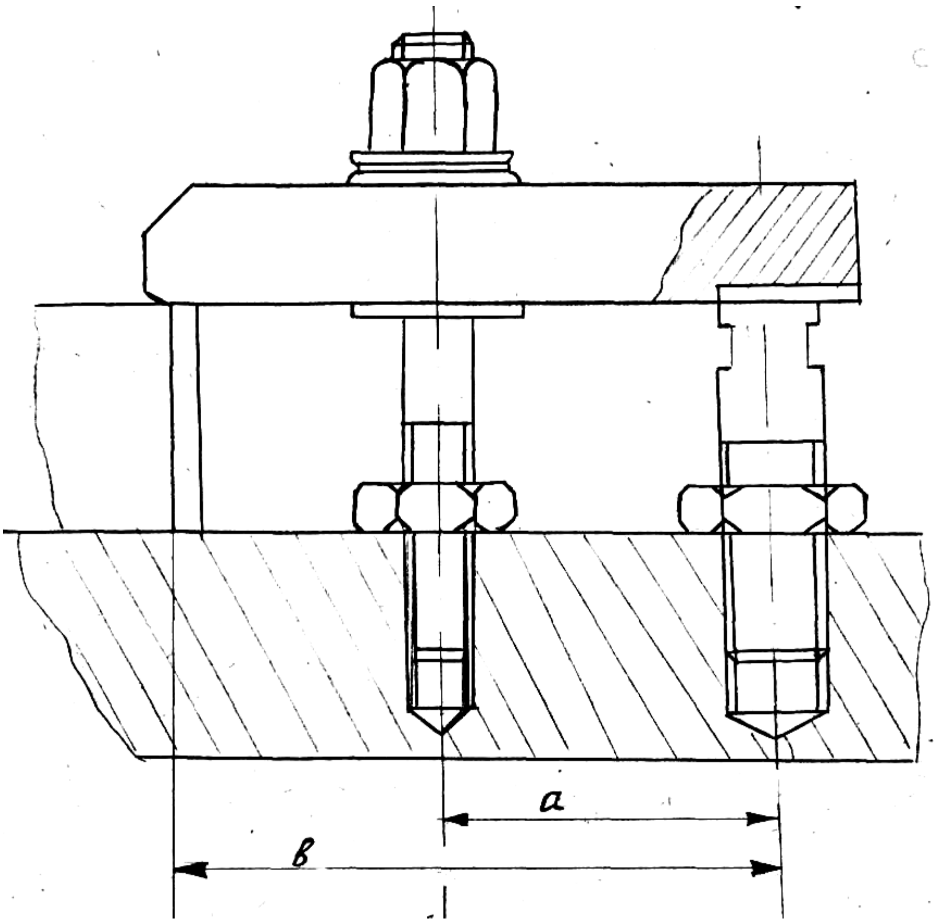

Figure 3.12 – Chart mechanism clamps

Description of turning devices

In terms washer 3 installed on the machine spindle centred and secured with four screws plug 5 devices.

Corps accessories are welded design. He placed a horizontal shelf 6 3 supports 11 and details of two sets of clamps 15. For greater rigidity and strength of the hull ribs provided rigidity.

Timber is three support parts 11 and 15. When the two sets of tightening nuts 13 clamping force clamps 15 and transmitted simultaneously via the second hinge arm clamps 15.

In the starting position clamps returned by the spring 16.

Accessories complete with workpiece from balancing. For the safety of cover provided 2. To correct the imbalance loads are (counterweight) 4, which are fixed by screws 14.

Device for measuring holes ∅43N8

Airflow constant pressure after the regulator nozzle 9 comes to 10 and 11 and is two separate streams.

One stream from the nozzle 10 enters the corrugated tubular spring 5 and 8 tube audited introduced in the hole.

The second stream of air from the nozzle 11 enters the siphon 15 and goes into the atmosphere through the screw back pressure regulator 12.

At the intersection of adjustment screw 12 outlet pressure siphon 15 remains constant. The pressure in the siphon 5 varies depending on the actual value of my size check your details.

Both siphons linked strip 4 of flat springs. The difference in pressure causes them to siphon deformation of the strip 4 moving towards the siphon with less pressure.

This siphon compressed with less pressure and more pressure on.

Moving through the slats 3 with a toothed sector and the return pipe 2 is relatively arrows 1 shkaly16 on which to count performance of the device. Price divisions 1 micron.

The device has electrical contacts, allowing you to use it as a sensor.

At the ends of the moving contact plate installed siphons 6 and 14 are (with tolerances) opens the lock and adjustable contacts 7 and 13.

Pneumatic gauge with siphon and differential measurement scheme has some significant advantages:

- High precision measurements;
- Speed adjustment (pattern matching);
- Ease of management and ease of use;

Working pressure (c) air siphon gauge 0,2 MPa

Calculation pneumatic parameters ∅43N8 (0.039)

The lowest limit:

Hole - 43,00mm

Admission - 0,039mm

Underreporting by working part:

43,00-0,004 = 42,996 ± 0,002 = 0.04, 42998mm

The diameter of the nozzle - 2mm

The diameter of the guide - 42,998-0,06-42,938-0,04mm

Calculation of cutting tools

Calculation tap

Projected tap used for cutting internal threads M23h0,75-64

Threading is performed in one pass. Processed material - aluminum alloy Al2 GOST20,85-75

Based on this number using teeth, tap Z = 4 (19T.62 p 632).

The diameters of the core tap:

$$b=0{,}22;\ d_0=0{,}22*23=5{,}06\text{mm}.$$

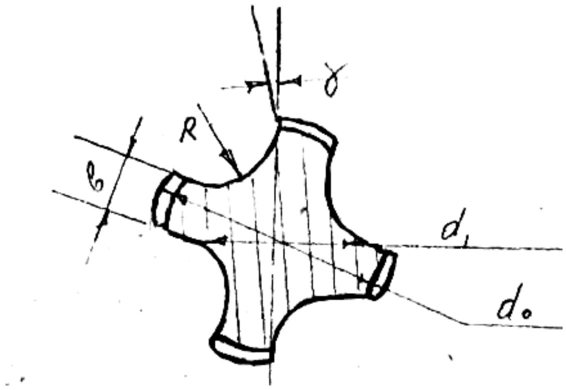

Figure 3.13 – Profile tap

The grooves in the taps should provide easy-east chips, have sufficient capacity and prevent jamming of chips at reversing tap.

$$R = \frac{d_0}{z} = \frac{23}{4} = 5{,}75mm$$

Maximum deviation of the front and rear corners should not exceed three (19, p 633).

The length of the fence taps:

$$l_1 = 63 - 6 \cdot 0{,}75 = 4{,}5mm.$$

The angle of the fence:

$$tg\varphi = \frac{d_0 - d_1}{2l_1};$$

Where d1 - the diameter of the original fence.

d'1 = d1 - the largest - (0.1-0.3) mm = 22,748-0,1 = 22,648mm.

Then tgγ = 23-22,648 / 2 × 4.5 = 0.0891; γ = 50

Fence delayed by angle α = 40 (19 S.638 T70)

Beats working part tap should not exceed 0,03mm centres. To reduce cutting forces make the gauge portion on the outer middle and inner diameter reverse obliquity less than 0.1 mm. 100mm in length.

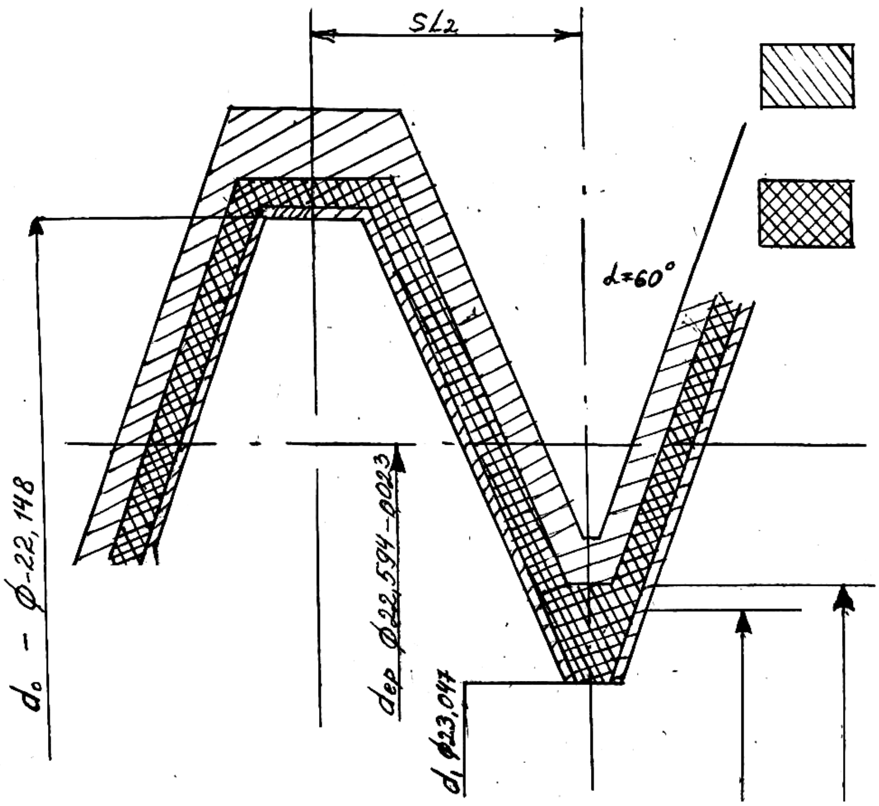

Figure 3.14 – Placement field tolerance share and tap

Calculation and design special cutting tools drill countersink

When processing details "casing" the transition milling - drilling - threading operations (drilling ∅9mm. And bevel cutting ∅16mm.) To save time concentrating elementary transitions using special drills, drills. Based on experimental data. Choose the angle at the top sverdla2Y = 1300 (17 s373).

Angle grooves for drill ∅9mm. take W = 400 (17, c362)

Find the value of pitch helical grooves:

$$H = \frac{\pi \cdot D}{tg\omega} = \frac{3{,}14 \cdot 9}{tg 40^{\circ}} = 34 \text{ mm.}$$

Assign diameter core drill:

K=(0,15-0,2)d = 0,15·9=*1,4*mm. [17, c361]

The specified angle is:

α = 10º [19 s113].

The angle of the transverse edges: γ = 50º [19 s104].

Determine belt width: f_{0max} = (0,32 / 0,45) = 0,33 · = 1,0mm.

Back drill diameter: mm.

where Δ - height tape;

Δ = 0,35mm. [17 C361A].

Then q = 9-2 · 0,35 = 8,3mm.

Find the radius of the groove drills:

$$R_к= (0{,}75/0{,}9)d = 0{,}75mm.$$

$$Z_n= (0.22/0.28)d=1.98mm.$$

Angle Q = 90º - angle helical grooves.

Withto reduce friction surface treated to drill the hole. The diameter of the working part perform reverse obliquity (decreasing diameter towards the shank) = 0,08mm. [17 C361A], the entire length of the working part of the drill.

Choosing geometrical parameters countersink angle of inclination chip grooves ω = 15º [17 s401] /

Front angle countersink cutting part = 0º

The rear angle α = 12º [17 s403] /

Other geometric parameters countersink GOST 14953-69 accepted by

D_1mm.	$d_1$mm.	$l_1$mm.	$d_1$mm.
16	8	15	18

Number of teeth Z = 4 countersink

For the combined drill tools - countersink uses tapered shank Morse 2 AT7 stSYeV144-75 made of steel 95 GOST 1050-74. Length 75mm.

Calculation and design of special drills, drills

The design designed drills, drills based on a standard design centring drill GOST 14952-85. Its feature is that instead of drilling depth 4,8mm. GOST 1495-85 drilled 10mm. and trim 1,5h450 serves to further threading in the drilled holes and countersink performed.

Accepted angle at the top.

$$2\gamma = 118 \pm 3^{\circ}; \text{ in drills } 2\gamma = 60^{\circ}\text{-}20$$

Drilling and countersinking parts have bowed groove angle of inclination of the axis (measured to the top of the drill). W = 5º [17. c392].

The diameter of the drill decreases toward countersink .... 0,05mm to 0.1 mm. at 25mm. length [17, s116].

With a view to decreasing of countersinking wall Lohman perform, as part adjacent to the working of grooves performed at the site of a limited angle of 30º-50º, the rest of the back cylindrical.

countersinks is in the form of cutting edges that ensure conical sections in the form of trims its surface is a continuation of the front surface of the affirmative, sharpen along with sharpening backs affirmative parts.

We take back angle drilling: $\alpha = 20$ [17, s113].

Determine the diameter core drill: $d = 0{,}17 \cdot D$; mm.

where D - diameter drill; mm. D = 2.5 mm.

$$d=0{,}17\cdot 2{,}5=0{,}43 \text{mm.}$$

Admission beating cutting edges: $\delta = 0{,}03$mm. (17, s393).

When using such a tool comes free chips from the cutting area by meredniy surface and strength increases.

The disadvantage of this tool is a combination of non-observance by thread size drill after drill change.

4 LIFE SAFETY IN EMERGENCIES

4.1 Life Safety at Workshop

Workshop are non-Laboratory situations where machinery and/or tools are used, in an indoor or outdoor situation. This advice also applies to fabrication, maintenance or other workshop-type activities not in the boundaries of a defined workshop area.

All workshops and stores must be under the direct control of a supervisor, who is responsible for ensuring they are maintained and used in a safe and healthy manner. Only those authorized to do so may enter or work in workshops or stores, and must comply with the requirements of the supervisor whilst in that area.

All persons using workshops and stores should apply good housekeeping practices, wear appropriate clothing and footwear, and use the workshop or store only for its intended purpose.

A tidy workplace makes it easier to spot and avoid hazards, and does not interfere with normal work operations. Good housekeeping is fundamental to workshop safety management, and the time allocated to a job must include cleaning up afterwards. This applies to both individual and shared areas.

Personal items, food, drink or cigarettes are not to be taken into workshops and stores, unless a clean work-free area has been set aside for this purpose. Where necessary, lockers should be provided and used.

The store or workshop must be suited to the proposed task. The supervisor shall make the decision as to what tasks are appropriate for each situation.

People can be struck and injured by moving parts of machinery or ejected material. Parts of the body can also be drawn in or trapped between rollers, belts and pulley drives.

• Sharp edges can cause cuts and severing injuries, sharp-pointed parts can cause stabbing or puncture the skin, and rough surface parts can cause friction or abrasion.

• People can be crushed, both between parts moving together or towards a fixed part of the machine, wall or other object, and two parts moving past one another can cause shearing.

• Parts of the machine, materials and emissions (such as steam or water) can be hot or cold enough to cause burns or scalds and electricity can cause electrical shock and burns.

• Injuries can also occur due to machinery becoming unreliable and developing faults or when machines are used improperly through inexperience or lack of training.

4.2 Life Safety in Machining Body Parts:

People can be struck and injured by moving parts of machinery or ejected material. Parts of the body can also be drawn in or trapped between rollers, belts and pulley drives.

Sharp edges can cause cuts and severing injuries, sharp-pointed parts can cause stabbing or puncture the skin, and rough surface parts can cause friction or abrasion.

People can be crushed, both between parts moving together or towards a fixed part of the machine, wall or other object, and two parts moving past one another can cause shearing.

Parts of the machine, materials and emissions (such as steam or water) can be hot or cold enough to cause burns or scalds and electricity can cause electrical shock and burns.

Injuries can also occur due to machinery becoming unreliable and developing faults or when machines are used improperly through inexperience or lack of training.

Precautions:

Check that the machine is complete, with all safeguards fitted, and free from defects. The term 'safeguarding' includes guards, interlocks, two-hand controls, light guards, pressure-sensitive mats etc. By law, the supplier must provide the right safeguards and inform buyers of any risks ('residual risks') that users need to be aware of and manage because they could not be designed out.

Produce a safe system of work for using and maintaining the machine. Maintenance may require the inspection of critical features where deterioration would cause a risk. Also look at the residual risks identified by the manufacturer in the information/ instructions provided with the machine and make sure they are included in the safe system of work.

Ensure every static machine has been installed properly and is stable (usually fixed down).

Choose the right machine for the job and do not put machines where customers or visitors may be exposed to risk.

Note that new machines should be CE marked and supplied with a Declaration of Conformity and instructions in English.

Make sure the machine is:

1) safe for any work that has to be done when setting up, during normal use, when clearing blockages, when carrying out repairs for breakdowns, and during planned maintenance

2) properly switched off, isolated or locked-off before taking any action to remove blockages, clean or adjust the machine

3) Also, make sure you identify and deal with the risks from: electrical, hydraulic or pneumatic power supplies

4) badly designed safeguards. These may be inconvenient to use or easily overridden, which could encourage your workers to risk injury and break the law. If they are, find out why they are doing it and take appropriate action to deal with the reasons/causes.

4.3 Life Safety for CNC Machines:

Slips and falls around machinery, injuries from unstable equipment, and faulty or ungrounded electrical components all pose significant dangers. Fire risks are also present in machine shops and depending on the type of equipment or machining operations, CNC machines could also be at a higher risk of fire.

Always assure that you wear proper ear armament and a good duo of safety glasses while operating a CNC machine. Ensure that your safety glasses are rigidly in place every time you are intently observing the cutting tools. If you have long hair, make sure that you keep it covered when you operate the CNC machine.

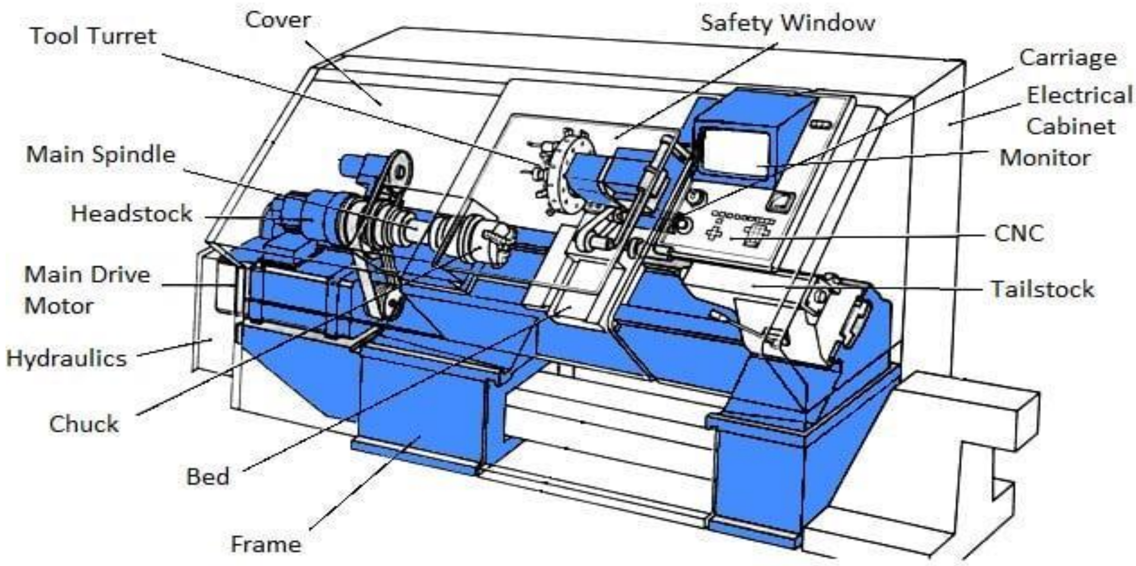

Figure 4.1 General view of a CNC Machine

GENERAL CONCLUSIONS

In this thesis, according to the task, a technological process of mechanical processing of the housing BL 8.013.016, was developed.

The characteristics of the service purpose and technical requirements for the part are analyzed, the basic technological process of manufacture is analyzed, alternative projects are offered.

Established the type and organizational form of production, the choice and economically justified method of obtaining the workpiece, conducted a structural analysis and synthesis of several variants of the technological process and established the optimal.

At detailed development of TP the allowance for interoperable sizes is established, the dimensional analysis is made, the cutting modes are determined, the technological equipment is selected, the control, auxiliary and transport operations are established, the valuation is carried out.

The performed works on designing the technological process of manufacturing the case BL 8.013.016 are aimed at increasing the efficiency of production, which is confirmed by technical and economic calculations.

The overall economic effect of implementing the project variant was 113625 UAH. The payback period for additional capital investments was 0.59 years.

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