НАВЧАЛЬНО-МЕТОДИЧНА ЛІТЕРАТУРА

ТНТУ

Ministry of Education and Science of Ukraine
Ternopil National Technical University named after. I. Puluj
Department of Mechanical Engineering Technology

Methodical instructions for performing practical work on the subject «Special technologies in mechanical engineering»

for students of all forms of study

Direction of preparation 131 " Applied mechanics"

Ternopil

2023

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

Mechanical Engineering
department

Methodical instructions for performing practical work on the subject
«Special technologies in mechanical engineering»
for students of all forms of study
Direction of preparation 131 " Applied mechanics"

Ternopil – 2023

V.R. Pankiv , V,S. Senchyshyn . Methodical instructions for performing practical work on the subject «Special technologies in mechanical engineering» for the training of specialists in the educational qualification level "Bachelor" in the direction of preparation 131 " Applied mechanics".

Compilers:

Pankiv V.R. - Ph.D; Associate Professor Mechanical Engineering department.

Sinchyshyn V,S. - Ph.D; Associate Professor Mechanical Engineering department.

Reviewers: **Stashkiv M.Ya.-** Ph.D., Associate Professor

Considered and approved at the meeting of the Mechanical Engineering department of the TNTU named after Ivan Puluj.

Protocol № 8 dated March 14, 2023.

Approved and recommended for publication by the scientific and methodical council of the Mechanics and Technology Faculty of the TNTU named after Ivan Puluj.

Protocol № 7 dated March 23, 2023

Composed taking into account the curriculum for bachelor Direction of preparation 131 " Applied mechanics".

INTRODUCTION

1. FEATURES OF TURNING PROCESSING

In small-scale production, turning is carried out on universal turning and turning machines. For roughing, one end of the shaft is fixed in a cam follower, which is mounted on the spindle faceplate of the machine tool. The support of the other end of the shaft may be a rotating rear center, mounted in the pinhole of the rear shaft.

Universal triangular self-centering turning cartridge has three cam, which simultaneously converge to or departs from the center. The installation of billets in cartridges is carried out in the processing of parts of a small length, and also the chuck cartridges are used.

Cams provide precise centering of the workpiece (coincidence of the axis of the workpiece with the spindle rotation axis). Cams 2 move in the radial grooves of the shell of the cartridge. In the case there is a disk, on the one hand there is a spiral carving, and on the other - chopped teeth. Cams with their projections on the basis of the spiral carving grooves.

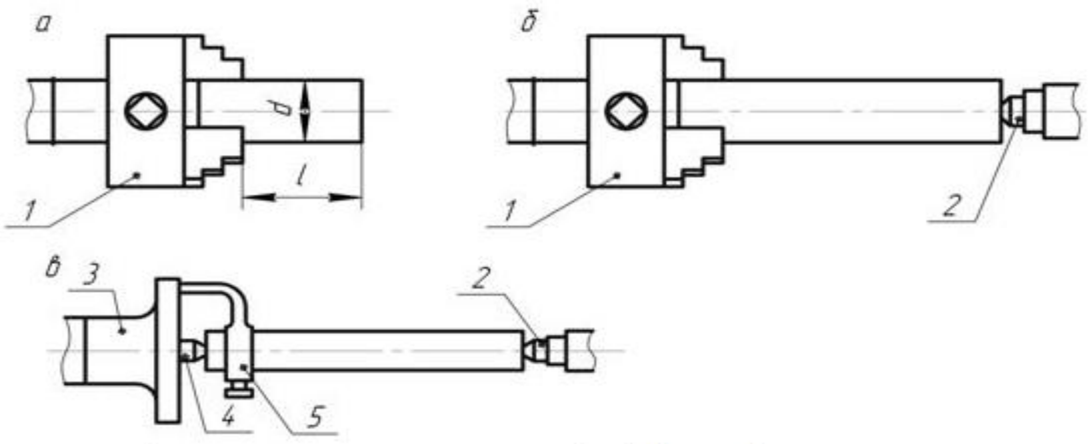


Figure 1 - Methods of installing a shaft when machined on universal lathe machines: a - in a three-stool cartridge; b - in a cartridge and a rotating center; in - in the centers using the lumbar clamp; 1 - cartridge; 2 - rotating center; 3 - faceplate; 5 - clam

Disc 4 is driven by a key that is inserted into the socket of one of the small toothed wheels attached to it. 1. The cartridge chuck moves to the center or center, fixing or releasing the workpiece. The working surfaces of the cams of the self-centering cartridge wear out unevenly, therefore they are periodically drilled or polished.

When finishing, the shafts are machined in the centers. For the transmission of the torque, the left end of the shaft is fixed in the lever arms.

When processing non-rigid shafts use lunets, which are an additional support. Lunets are stationary or mobile. The fixed lunette is mounted on the longitudinal guide rails. The rolling lunette is mounted on a longitudinal belt and is moved during the processing together with the belt. A movable lunette creates an additional support, which is always located in front of the cutter. Therefore, the deformation of the shaft under the action of cutting power is less than when using a real lunette.

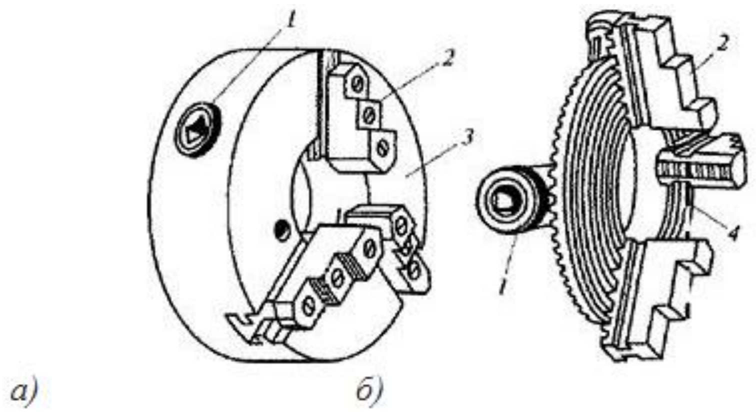


Figure 2- Three-neck self-centering cartridge: a - general appearance; b - details of the cartridge; 1 - conical gear; 2 - fists; 3 - body; 4 - a disk, on the one hand is a spiral cutting, on the other – teeth

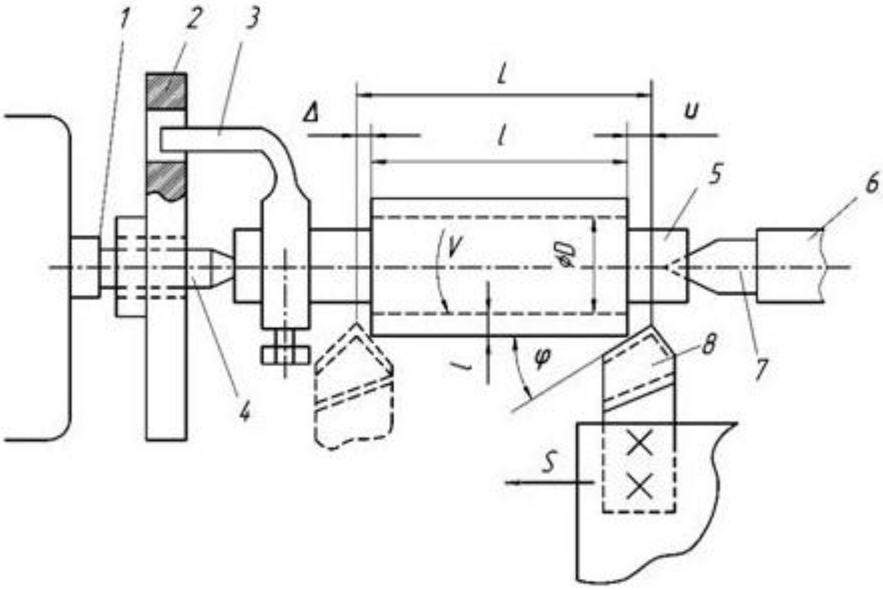


Figure 3 - Scheme of machining roller when installed in centers using a lever

In the serial production for turning processing are used turning-bending CNC machines. The machines are equipped with 6- and 8-position tool heads with a horizontal axis. The head is installed on the support of the machine tool. The installation of cutters, fixed in the head to the working position, is carried out at the expense of turning the head. CNC turning machines are used for machining shafts with complex step and curvilinear posts, including cutting threads.

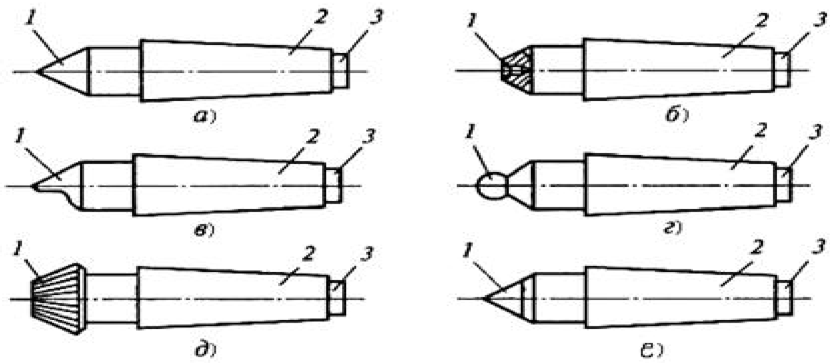
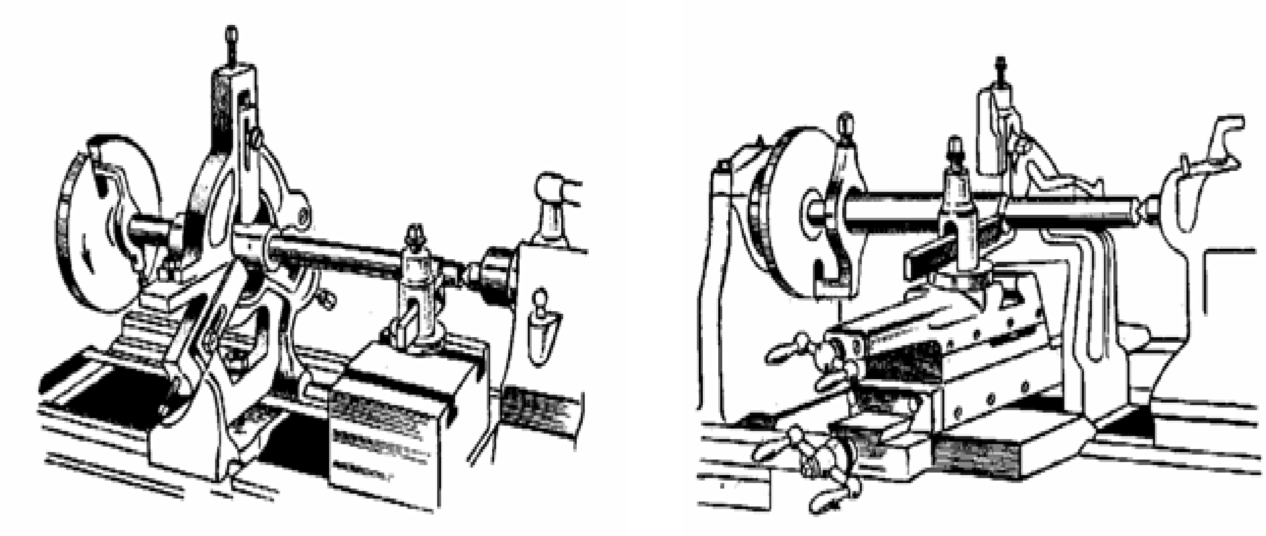


Figure 4 - Types of Cents; a - persistent; b - inverse; in - half center persistent; g - center with spherical working part; d - with a corrugated surface of the working part of the cone; yes - with a carbide tip; 1 - working part; 2 - tail section; 3 - the support part



а) б)

Figure 5 - Treatment of a shaft on a turning center in centers: a - with a fixed lunette; B - with a moving lunette

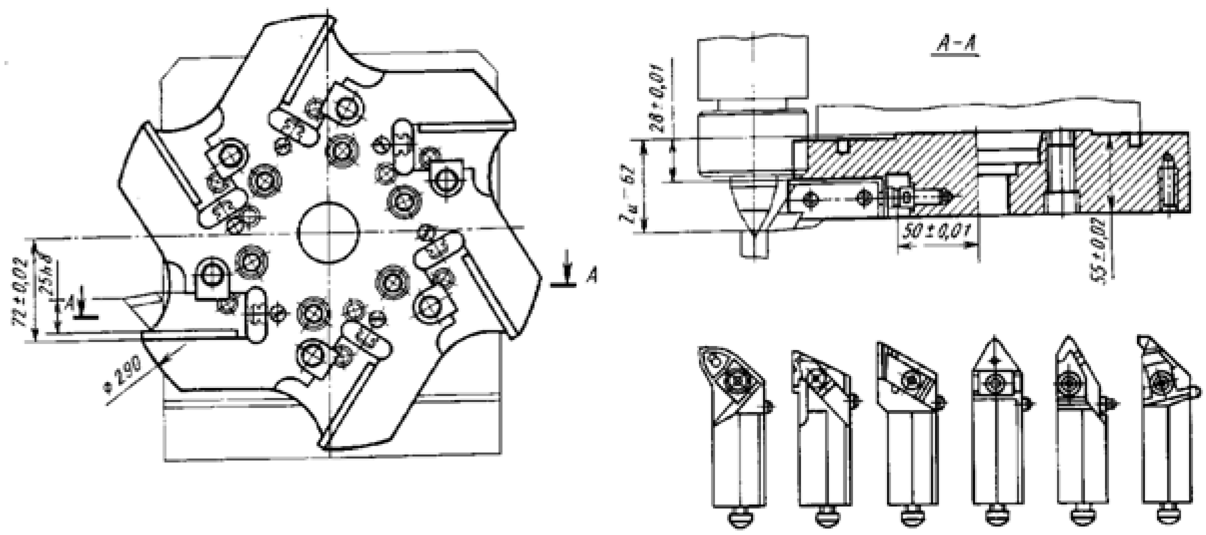


Figure 6 - Six-position tool head of CNC machine 16K20F3 with a set of cutters

In large-scale production for the processing of shafts used turning multi-part semiautomatic and turning gidrokopirvalnye semiautomatic devices. In shows the shaft processing scheme on a multi-axis semiautomatic machine. The machining accuracy depends to a large extent on the number of cutters. With a large number of cutters there are large deformations of the VPS system. Therefore, the accuracy of machining on these machines is small and reaches 10-11 qualifications.

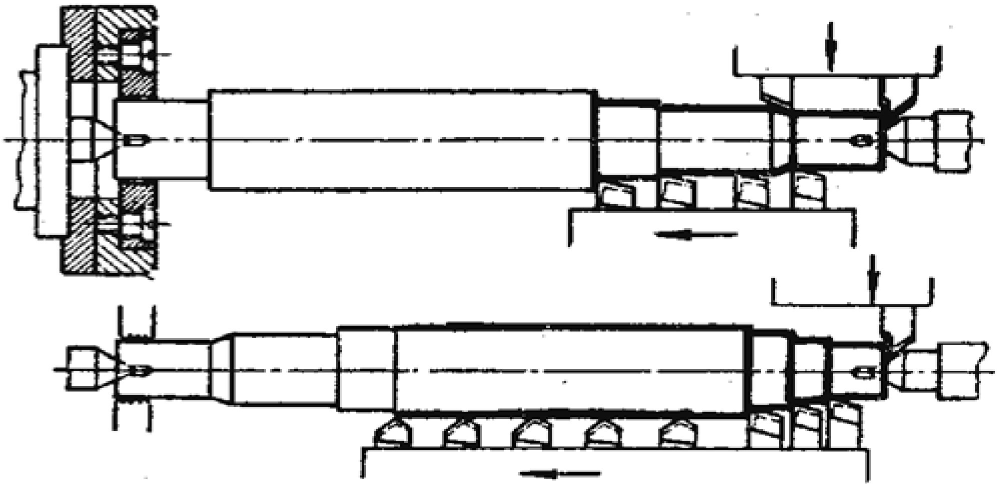


Figure 7 - Scheme of shaft processing on a multi-axial semiautomatic machine

The use of multi-thread processing reduces machine time, since. the length of the transfer of the carriage decreases. At the same time, the time spent on setting up the machine increases, as the share of preparatory-final time and maintenance time increases.

The machine has two bearings - the upper and lower. The upper caliper is hydro-copying and is intended for longitudinal turning of the shaft. It is fixed in one cutter. Lower calf is multicolored. It has only a transverse feed and is intended for the transverse cutting of the ledges by wide incisors, trimming the ends and processing grooves. Since one cutter participates in the longitudinal sharpening in the cutting, the deformation of the VPS system is smaller, and the precision of processing is higher by about one qualifier than with multi-treatment. In addition, the time to adjust the machine through the processing of parts with one cutter and the simplicity of installing a copier is smaller than that of dual-spindle semiautomatic devices.

TASK. 1. The purpose of universal turning and turning machines?

2. Benefits of multi-thread processing?

2.TREATMENT OF GROOVES SURFACES

Shaft and splice joints are used for the transmission of torque. Shaped connections are provided with prismatic, wedge and segment keys. Shaped grooves for prismatic keyboards can be closed on both sides (deaf), closed on one side and crosswise. Cross-cut and closed from one side, the slot grooves are manufactured by milling the disk mills on horizontal milling machines for one or two working steps. The application of this method provides sufficient productivity and precision of the width of the key groove. Through grooves can be processed on planing machines.

Deleted side-grooves are made by a final cutter on vertical milling machines with a longitudinal or swivel feed. In the first case, the milling cutter is fed by a vertical feed to the full depth of the key groove, and then the longitudinal feed is activated and the groove is processed along the entire length. The width of the slot with such a processing scheme is low due to the fact that the allowance is removed in one working step and the milling tool wears out very quickly. In order to facilitate the work of the cutters, it is often pre-drilled a hole of smaller diameter than the cutter at the depth of the slotted groove, and then the axial feed is fed into the cutter and the groove is machined.

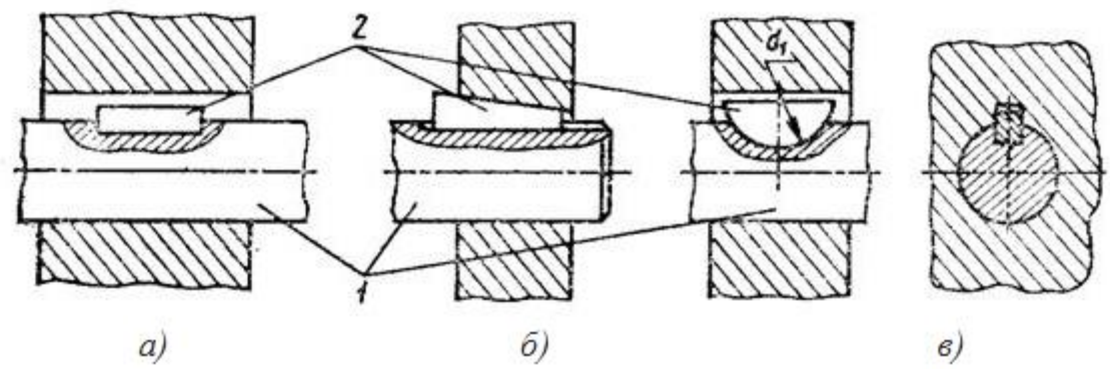


Figure 8 - Types of key connections: a - prismatic; b - wedge; in - segment keys; 1 - shaft, 2 – grooves

Apply swivel feed to obtain precise widths of keyed grooves. In this case, the cutting of the cutter is 0.1-0.3 mm, followed by a longitudinal feed. At the end of the groove, the cutter cuts again to the same depth and the groove is milled in the opposite direction. In this case, the accuracy of the groove in width corresponds to 8-9 qualities, and the roughness of the lateral surface is 5 microns.

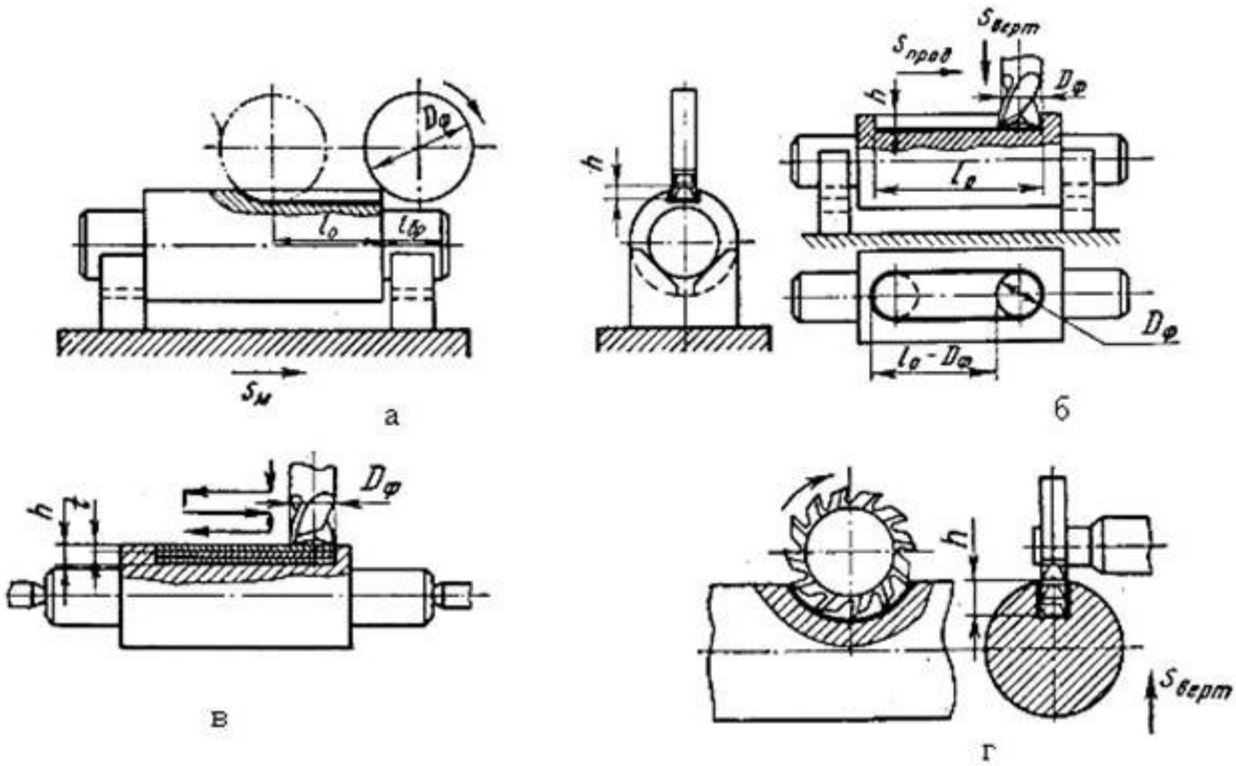


Figure 9 - Molding groove methods: a - a disk cutter with a longitudinal feed; b - the longitudinal feeder with the final cutter; c - a finite cutter with a pendulum feed; g - a disk mill with a vertical feed

The grooves for segment keys are made by milling on horizontal milling machines with disk drives with vertical feed (Fig. 2.33 g).

Production of split surfaces. Slice joints are with straight-line, elliptical, and triangular teeth. The centering of the sleeve with respect to the shaft is carried out on the outside, along the inner diameter of the shaft and the lateral surface of the teeth. When aligning the internal diameter of the shaft, the connection is executed according to scheme I. When aligning on the outer diameter and the lateral surface of the teeth, perform the execution according to scheme II.

Slices on the shafts are cut by milling, planing, stretching and cold plating.

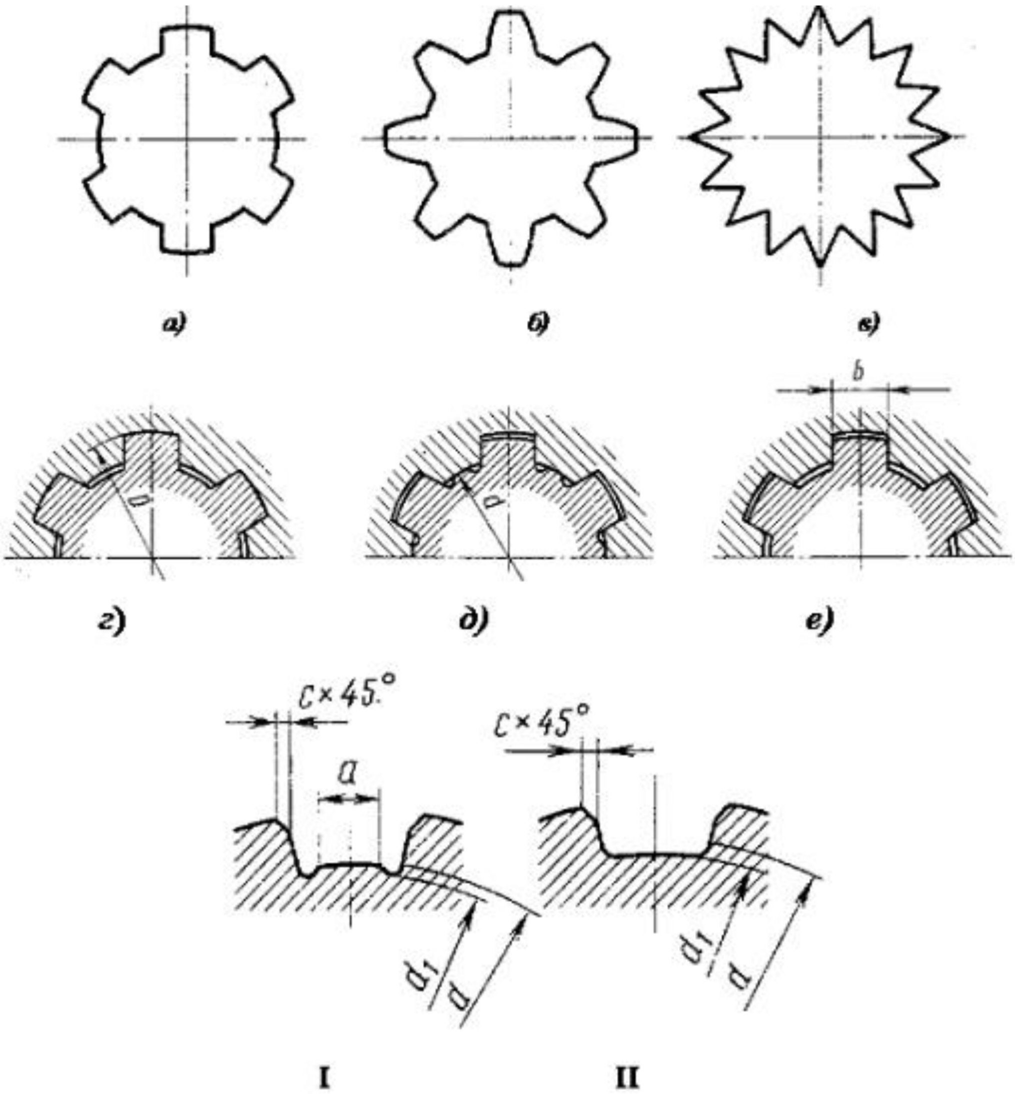


Figure 10 - Slice connections: a - straight-ahead; b - immovable; in - triangular; d - with centering on the outer diameter; d - centered on the inside diameter; e - with centering on the lateral surface of the teeth; I - types of tooth execution at centering on the inside diameter; II - types of tooth execution at centering on the outer diameter and the lateral surface of the teeth

Milling of slots is carried out mainly in two ways: with the use of dividing mechanisms with one or two disk shaped cutters or by the method of rolling the worm mill (Fig. 37 a, b, c). Application of the second method provides higher productivity, as well as precision along the groove width and tooth pitch, but requires the use of special slitting mills. In connection with higher productivity, the second method is used in large-scale and mass production. When centrifuging the sleeve on the inner diameter of the shaft disk and worm cutters should have "mustaches" to form grooves near the tooth base, which are necessary for the exit of the circle when grinding the lateral surface and bottom of the depression of the slots. The machining accuracy after milling corresponds to 9-10 qualities, and the roughness is 5 ... 10 microns.

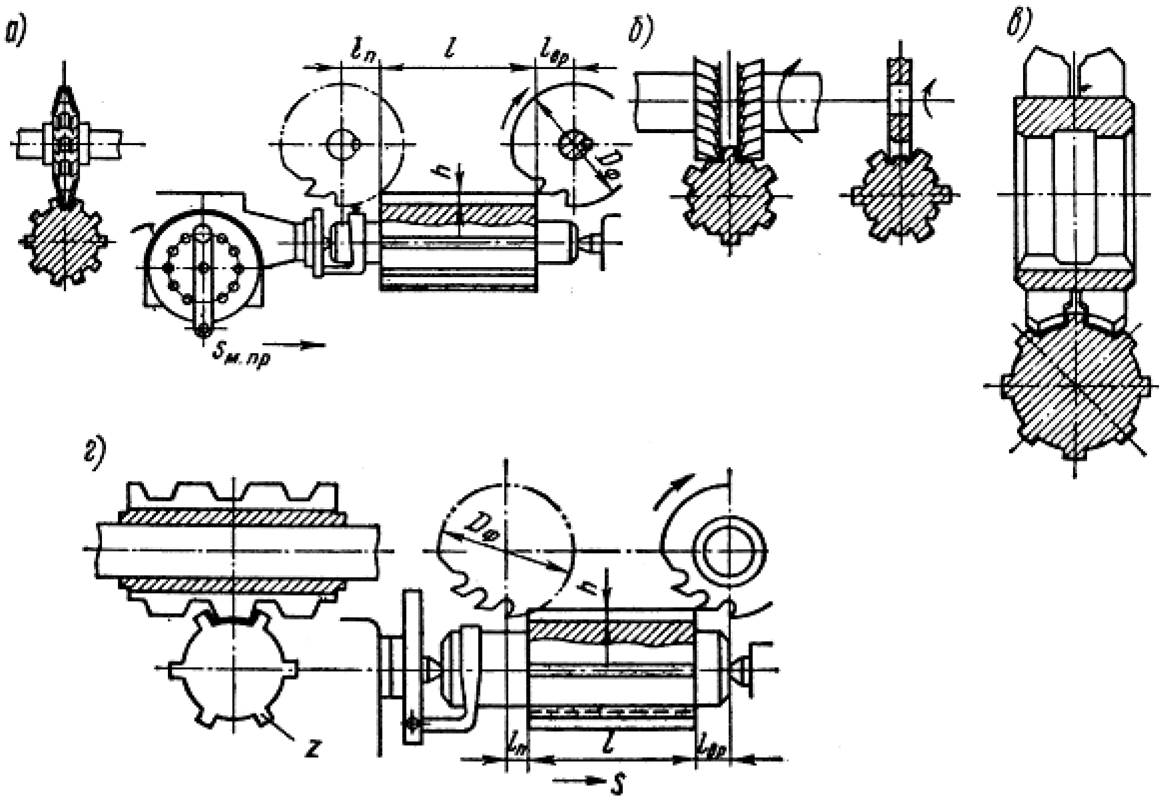


Figure 11 - Ways of milling the slots: a - one disk mill; B - a worm mill; in - two disk mills; g - disk mill with mustache

Plotting slots is done by copying with a multi-threaded head on a special machine. The cutters have the shape of the hollow slots and are installed in the body of the head, with the possibility of synchronous movement in the radial direction. When planing in one double turn (forward and backward), the radial feed of the cutters is carried out to the depth of cutting. This feed is provided by the design of the head. By this method the through and deaf slices in height 25-30 mm are processed. In the latter case, in the design of the shaft there is a groove for the output of the cutters. The precision of the machining is provided by the geometry of the incisors, as well as the accuracy of positioning the incisors in the head. The surface roughness of the slots is 1.25 ... 2.5 microns.

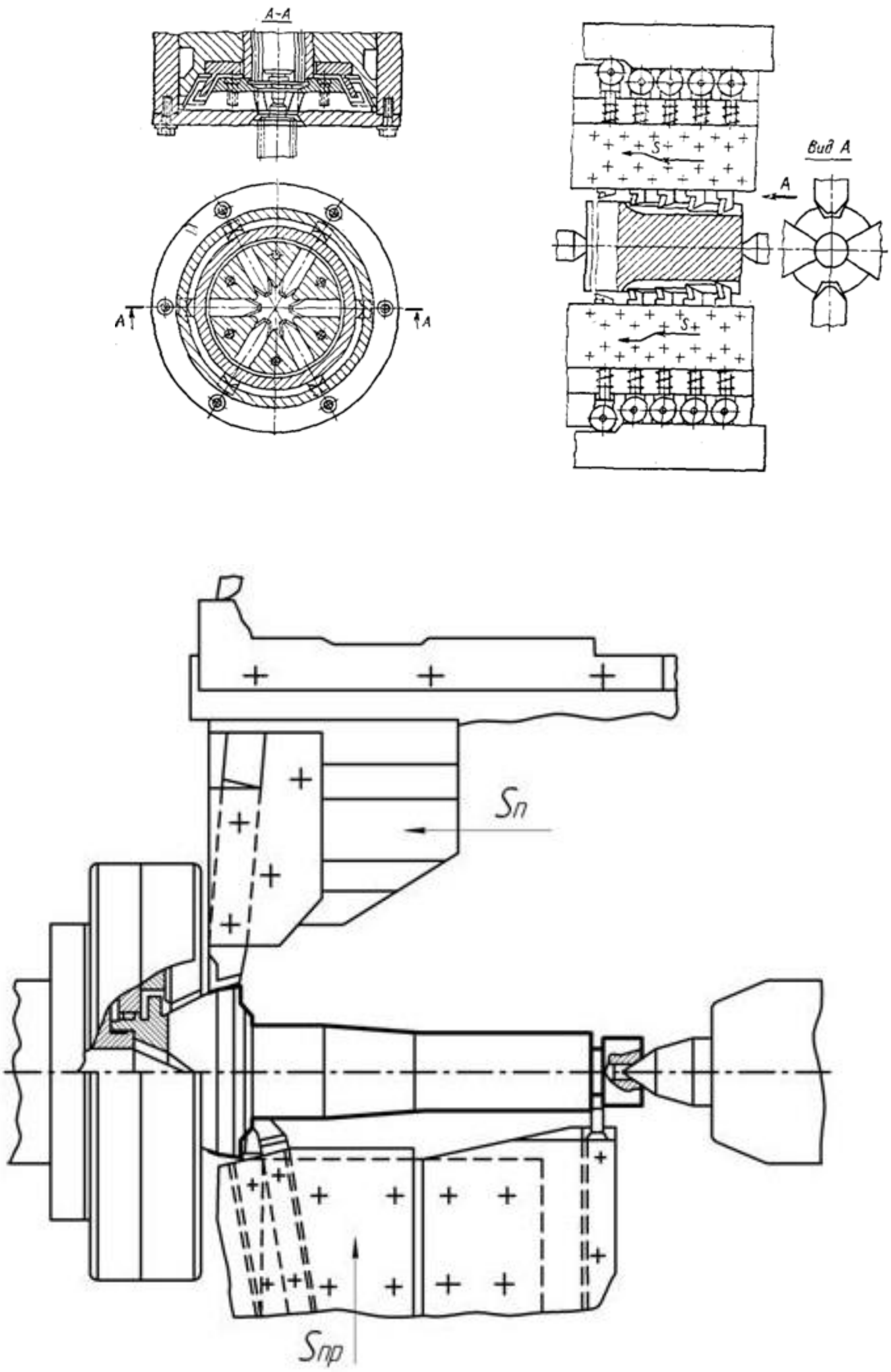


Figure 12 - Scheme of machining of the shaft-gear on a hydro-copier semi-automatic machine: 1 - copier; 2 - upper caliper, 3 - lower caliper

The principle of the operation of the copying control system with a hydraulic tracking actuator, which has a mechanical feedback and is used on a lathe for manufacturing from the workpiece of the 4 shaped parts 5 by copier 8. The hydraulic pump, when operating the system, supplies the lubricant under pressure Rn to the right cavity of the hydraulic cylinder 1, and the left cavity is connected to the drain pipe Pc.

As a result of the pressure difference, the piston of the hydraulic cylinder 1 with the stroke will begin to move along the Z axis, taking with it the track of the tracking actuator 2. The throttle hydraulic distributor, 7 connected with pressure Rn and drain Ps pipelines. The longitudinal movement (along the Z axis) of the probe 9 in copier 8 causes the displacement of the hydraulic distributor 7 to be in relation to the housing in which it is located. The tear off of the probe 9 from the working surface of the copier 8 eliminates the spring 6 of the water distributor. As a result of the displacement of the hydrospodidilitelya with respect to the body of the trailing hydraulic actuator 2 open the throttling cracks formed by the body and hydraulic distributor. Cavities A and B cylinder are connected in accordance with pressure and drainage pipelines. The drop in pressure on the piston of the trailing hydraulic actuator 2 causes the displacement of the actuator body to be shifted by the hydraulic distributor, 7 which is followed by the movement of the probe on the copier. The displacement of the body of the hydraulic actuator 2 is transmitted to the cutter 3, which is rigidly connected to the housing. Thus, the cutter 3 receives a longitudinal displacement (along the Z axis) from the cylinder 1, and a transverse displacement (along the X axis) from the body of the hydraulic actuator 2.

Copy systems are widely used to control the processing of parts by one, two and three coordinates. The ability to quickly change the program carrier (copier) allows you to use them in serial production.

Analogue control systems allow you to improve the machining performance, but do not have sufficient flexibility. This results in a high cost of re-equipment of the equipment.

In mass production for processing of shafts are used six or eight spindle turning semiautomatic devices of vertical type. The machine has a turntable, in the center of which is a six or octagonal column. On the edges of the column installed three types of support: longitudinal, transverse and longitudinal transverse towing. The last caliper has slides for longitudinal and transverse movement of the incisors.

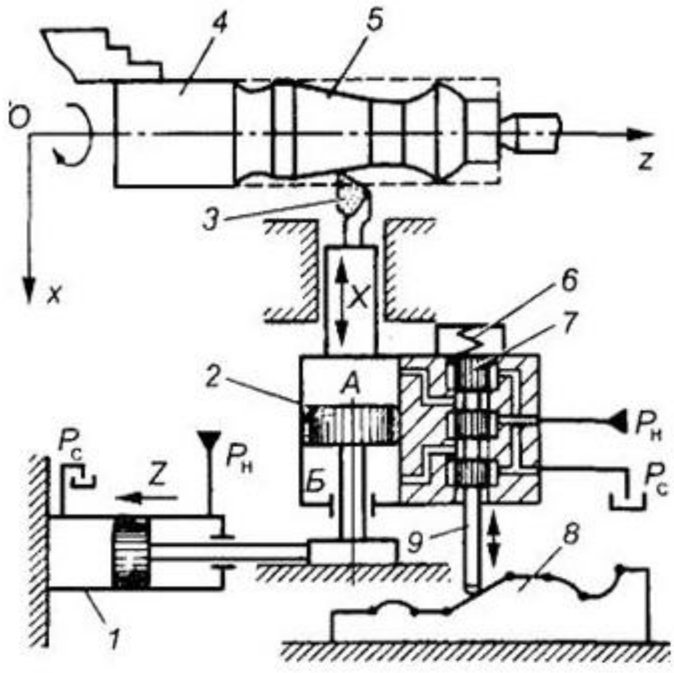


Figure 13 - Copy control system with hydraulic tracking drive and mechanical feedback: 1 - hydraulic cylinder; 2 - hydraulic drive; 3 - cutter; 4 - workpiece; 5 - shaped part of the part; 6 - a spring; 7 - hydraulic distributor; 8 - copier; 9 – probe

Opposite to each side of the column are rotary spindles with levers for mounting shafts in the centers. In accordance with Fig. 14, processing on the machine is carried out according to the following scheme. In positions I the loading of the machine is carried out. In these positions, the shaft is processed on one side. In position II rollers are reinstalled, processed on the other side and removed from the machine. Thus, on the machine at the same time, the six parts are threaded. Therefore, for one turn of the table, 18 shafts are stretched from both sides.

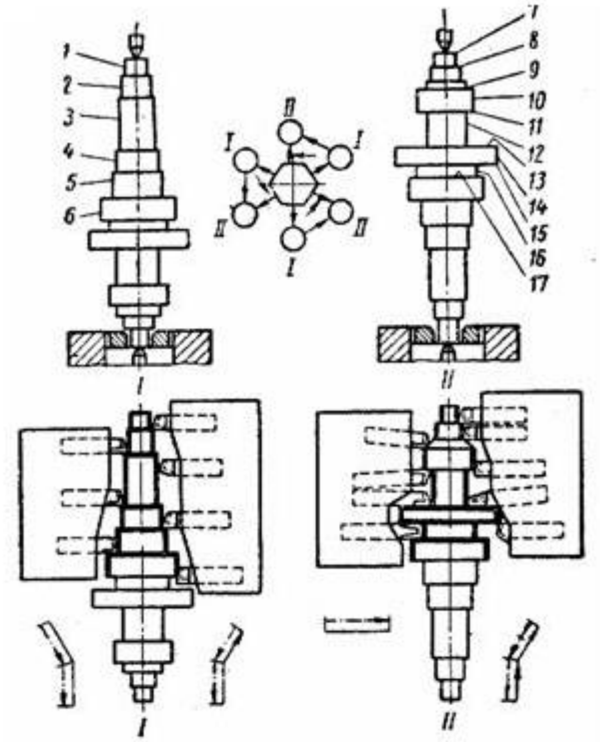


Figure 14 - Scheme of shaft processing on a vertical multi-spindle semiautomatic machine

The machine can be adjusted to a different scheme of which one of the positions rotary table is loading and unloading, and the other is sequential processing shaft with one hand. For machining the shaft, the machine is changed or debugged on the other hand.

Turning of small-size shafts (rollers) on revolving machines and automatic machines.

Small shafts are made of bars. Revolving machines and automatic machines are designed for multistep machining. Lathe setup includes a large number of cutting tools customized to the size of the product, which allows machining parts of complex shape transitions and match the processing. This eliminates the time required for the installation and adjustment of the cutting tool when machining different surfaces. Thus, the machine is adjusted once to process the part as a whole.

Turning-revolving machines are used in small and medium-scale production. These machines are equipped with a revolving head with a vertical or horizontal axis. For details on the treatment Rotary-revolving machine tools used chisels, drills, core drills, reamer, taps, dies, which by-fixed calipers and tool holders in the nests revolving head using bushes, chucks and racks. Various technological schemes for the processing of parts such as rollers on lathe revolving machines are shown in Fig. 15. In the finishing processing on turning and precision machining revolving machines accuracy reaches 7-8, and surface roughness - 2.5 microns and above.

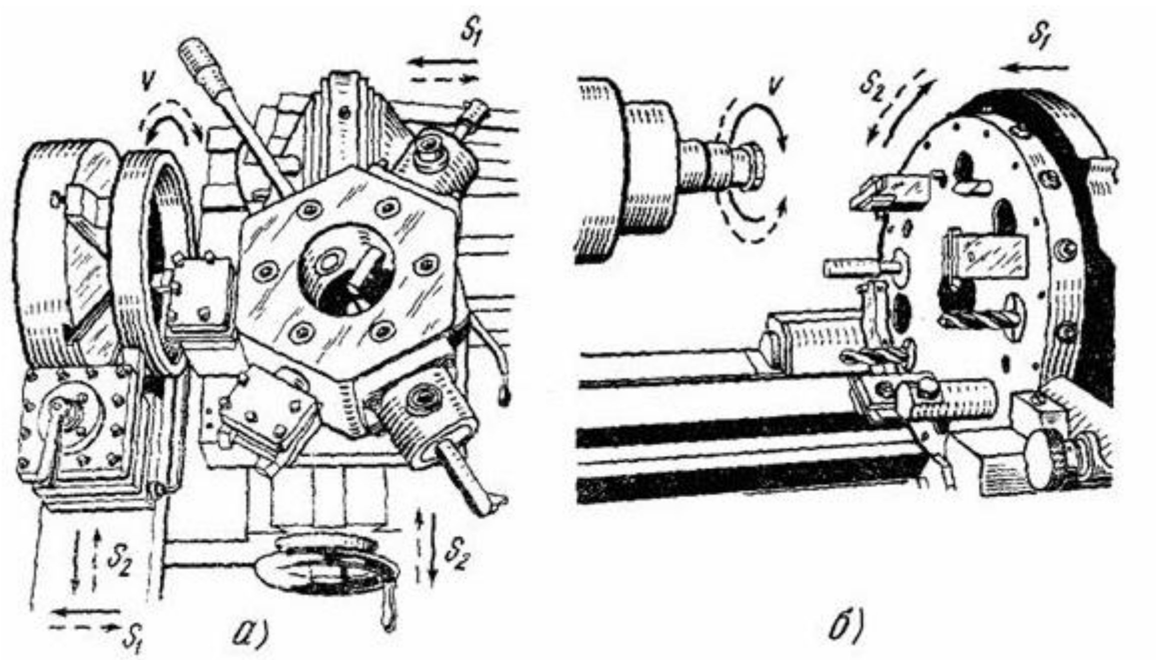


Figure 15 - Lathe revolving machines: a - with a horizontal axis of the revolving head; B - with the vertical axis of the revolving head

The extension of the slots is carried out by two block drafts installed opposite each other. Thus, at the same time, two depressions are treated with the subsequent rotation of the shaft on one slit step and the process is repeated. The toothed teeth are cutters, mounted in the body and spring-loaded in the direction from the axis of the shaft. The rear part of the cutters is connected with rollers, which, when moving drafts, roll over the copier. The shape of the copier provides the removal of incisors under the action of springs at the end of the treated area. Accuracy and roughness during slipping is the same as in plantation. The productivity of planing and stretching is higher than milling in 5-8 times.

After machining, the shafts are quenched or refined. When thermal treatment there are deformation details. To correct the errors of the heat treatment, apply grinding slots. Depending on the alignment method, the grinding of the outer or inner diameter and the side surfaces of the slots is required. Grinding on the outer surface is made on conventional grinding machines .

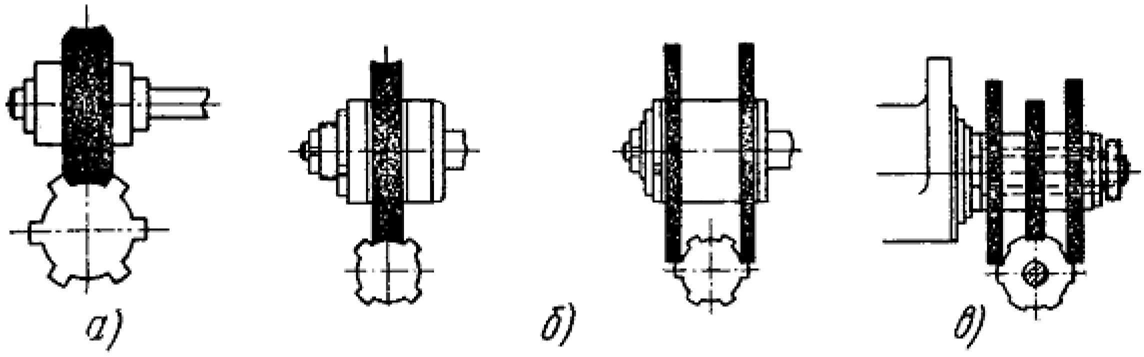


Figure 16 - Methods of grinding slit: a - shaped circle; b - separated by two circles; in - at the same time in three circles

When aligning the sleeve with the inner diameter of the shaft or the side surfaces of the slots, in addition to grinding these surfaces, conduct grinding and bottom of the depression. In this case, the most productive method of grinding is the grinding of a shaped circle, separated by two circles or simultaneous grinding several circles. After grinding accuracy increases to 8-9 qualities, and roughness is 0.63 ... 1.25 microns.

The slipping of the slides is carried out by the method of plastic deformation of the metal in a cold state, that is, without heating it. Exercises are performed with toothed rollers, rails and smooth rollers. When rolling with toothed rollers and rails, the process of toothed engagement is simulated with extrusion of metal from the grooves of the slots. When casting smooth rollers, each roller is treated with one groove. The drawing of toothed rollers and rails gives impulse slides. Rectangular slices are rolled up with smooth rollers. By drawing, small slices up to 2.5 mm high with their large number. Strengthening of metal during rooting increases its mechanical properties. This allows you to give up the heat treatment and grinding slots. When casting provides high precision and low roughness of the surface to be processed. Productivity when poured 10 times higher than during milling.

The external thread is threaded with threaded cutters, dies, comb, threaded cutters and threaded heads. Inner thread is cut with cutters and taps.

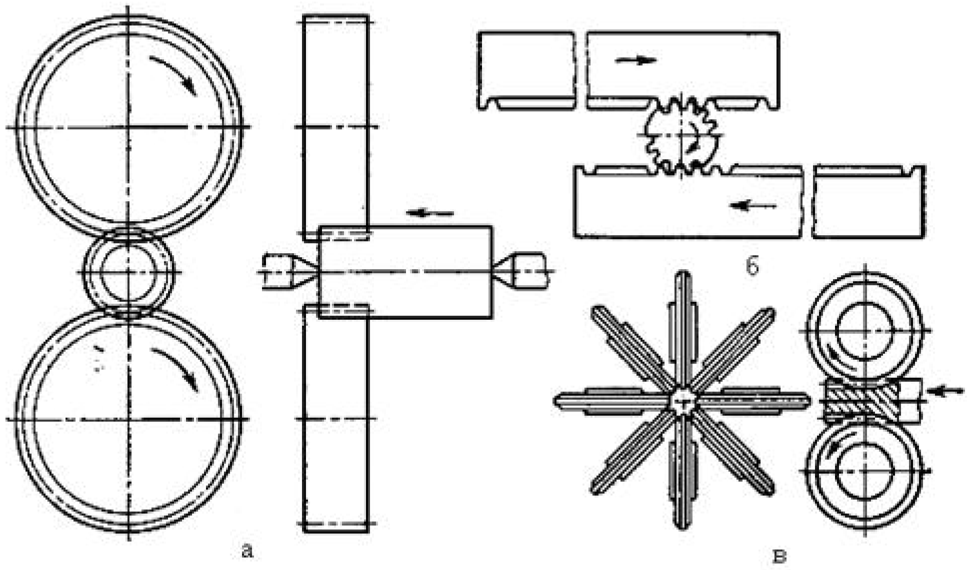


Figure 17 - Drawings of slots: a - toothed rollers; b - rails; in - smooth rollers

The external thread is threaded with threaded cutters, dies, comb, threaded cutters and threaded heads. Inner thread is cut with cutters and taps.

TASK

1. The purpose of the shafts?
2. Types of shafts?
3. The main methods of processing grooves?
4. The principle of the operation of the copying control system?
5. The purpose of revolving machines and automatic machines?

3.THREAD CUTTING

The cutting of the external and internal threads by cutters in small-scale production is performed on lathe-screw machine tools. Schemes of threading external and internal threading cutters are presented in Fig. 18. Because of low strength of the workpiece of the cutting tool is performed in several work steps. Moving the support during threading is carried out from the screw. After each working step, the cutter is pulled from the part and the reverse of the screw moves the caliper to its original position. Then the cutter is again drawn to the workpiece, set the required depth of cutting and repeat the working process. The precision of the thread during machining is equal to the sixth degree of accuracy with the tolerance field, for example, 6g. In this case, the shaft or hole under the carving is treated to 7 qualifications.

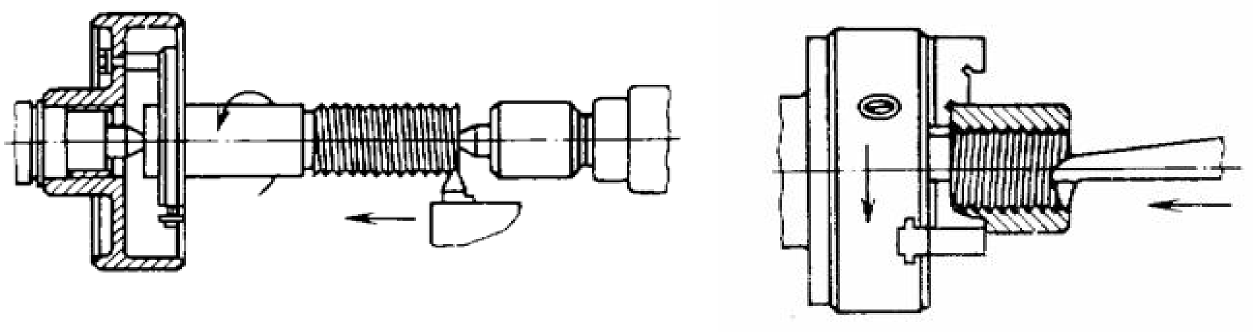


Figure 18 - Schemes of thread cutting by cutters: a - external; B – internal

The cutting of the thread with round plates is performed on turning, turning-turning machine tools and turning machines. The accuracy of the carving is low and corresponds to the eighth degree of accuracy.

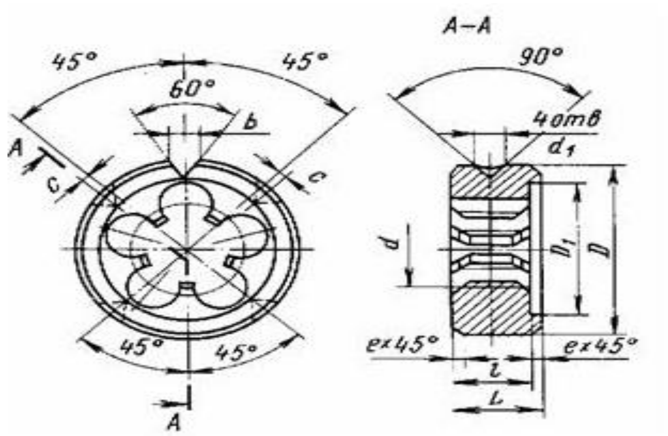


Figure 19- Round die

The main drawback of the dies is the need to screw them down by threading, which causes considerable time consuming and impairs the quality of the carving.

The cutting of the carving with the variegated heads, which are themselves disclosed, is much more productive than the threading, and does not require them to be screwed again by automatic discovery. Reignary heads of normalized design are made serially with tangential and radial arrangement of dies, as well as with round plates. At the end of the cutting, the carving of the dies or combs automaticallydisperses and in the opposite course do not come into contact with the thread.

The cutting of self-rotating heads with flat and round comb is performed on the same machine tools. Combs are placed in the body of the head around the workpiece. When threading a thread with a comb permission is distributed between its teeth, whose height gradually increases from one edge of the comb to another. The productivity of threading heads is approximately twice as high as when threaded, as at the end of the workflow the head is automatically opened, the combs are dislodged, and the time for screwing the tool is not spent. The precision of the thread is higher than when threaded.

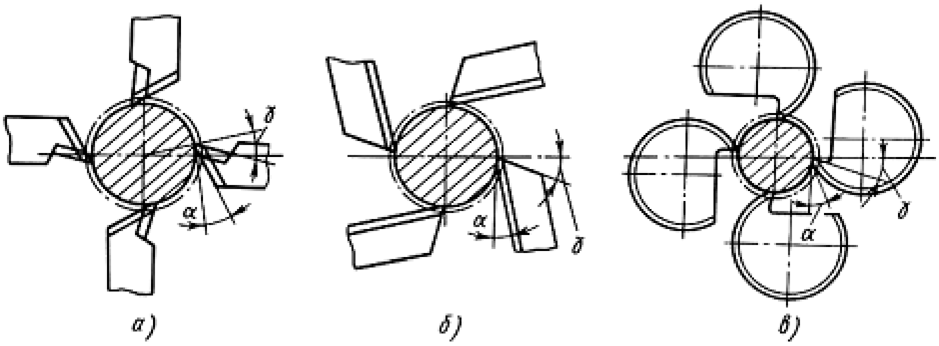


Figure 20 - Threaded cutting screw heads:

a - radial; b - tangential; in – round

Milling of a carving Milling of external and internal carving is widely used in production and is executed on thread-boring machines in two ways: disk mills and group (comb) cutters. Milling of long threads with a large step and a large profile (more than 4 mm) is carried out by a disk mill. The cutter profile corresponds to the thread profile. The milling axis is located at an angle a to the axis of the part, equal to the inclination angle of the thread.

Disc mills can be symmetrical (Fig. 21 b) and asymmetrical (Fig. 22 a). When threading the thread milling rotates and has a translational motion along the axis of the part, and the movement in one turn of the part must exactly correspond to the step of the thread. The parts rotate slowly according to the feed.

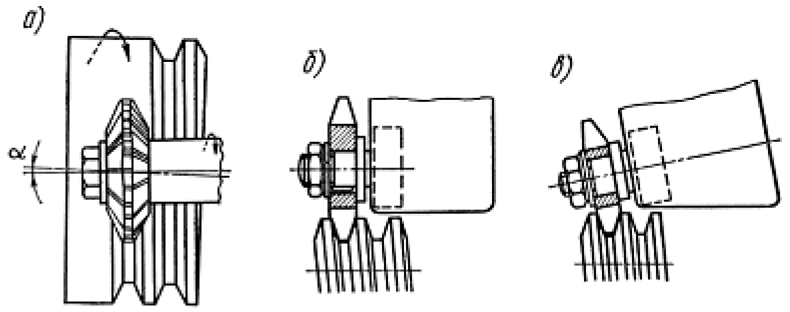


Figure 21 - Milling with a disk mill: a - displacement of the axes of the cutter and the part; b - cutter of symmetric profile; in - milling of asymmetric profile

Milling of short threads with a small step is carried out on thread-milling machines with group (comb) cutters. The group cutter is like a group of disk mills assembled on one mandrel. The length of the cutter is usually taken at 2-5 mm longer than the milling thread length. A group cutter for threading is installed in parallel with the axis of the part. In advance, cutting cutters to the depth of the carving. In the case of a full turn of the parts, the milling cutter moves to the size of the thread of the thread. Milling takes place for 1.2 turns of the part; A 0.2 turn is required for cutting and overlapping the cutting area .

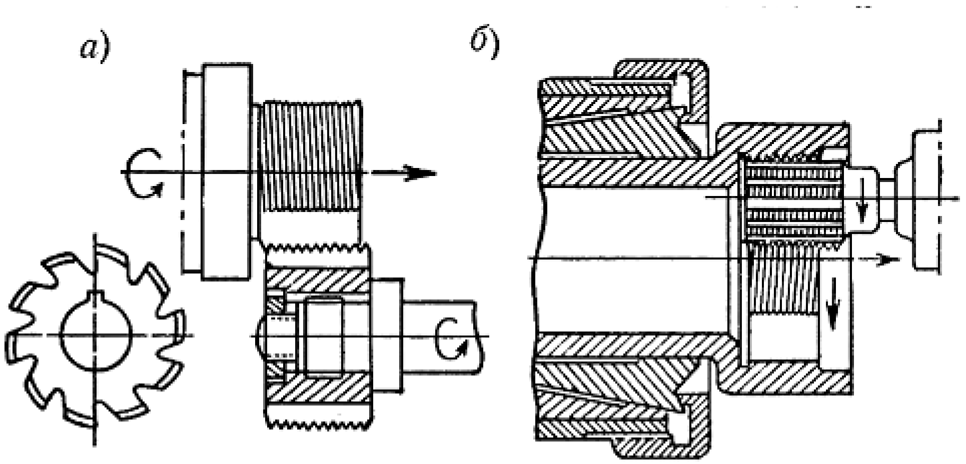


Figure 22 - Schemes of milling of a carving with group cutters: a - external carving; B - internal carving

The inner thread is tapped with taps, which are manual and machine. Hand taps are used in a set of two or three pieces. Manual taps cut metric thread with a diameter of 1-52 mm, as well as other types of carving: pipe, inch, and others. In the machine variant, as a rule, one tag is used, which is cut by a short carving.

The accuracy of the metric threaded sliced taps corresponds to a degree of accuracy of 6-8. For cutting internal threads on revolving machines and automatic machines, thread-cutting heads are used with sliding flat dies (Fig. 23). The principle of these heads is similar to the principle of the heads for threading external threads.

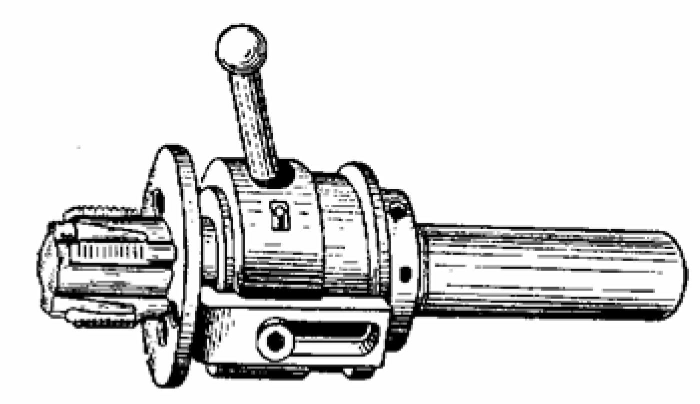


Figure 23 - The head for threading the inner thread by the dies

The threading of the thread is carried out by plastic deformation of the metal in a cold state without the removal of chips. Threads are rolled up with flat dies or rollers. The thread after the roll has a high accuracy and low roughness of the surface. Scheme of rolling of threaded dies is presented in Figure 48. The bottom plate 1 during stacking remains stationary, and the upper 2 has a reciprocating motion in the horizontal direction. The working surface of the dies is a screw thread on the plane with the profile and the angle of lifting of the rolled thread. When moving the dowel forward, the part screwed through the grooves from the position 3 to the position 4. When the back of the top plate, the part returns to its original position and thrown out of the machining zone. Thus, the carving is carried out in one double turn of the dies. Machine tools for threading flat dies have high performance and make up to 280 double moves per minute.

The rolling of carving rollers is carried out on turning machines and special automatic machines according to different schemes. The rolling of a carving with one roller is used on lathe-screw driving and lathe-revolving machine tools (Fig. 24). The workpiece 1 is clipped in a cartridge or a toolkit. The threaded roller 2 is fixed in the holder 3 and is installed in the cutter or the revolving head of the 4 machine tool. Threading on the roller has a reverse direction than the carving on the workpiece, that is, the right carving is spun with a roller with the left thread and vice versa.

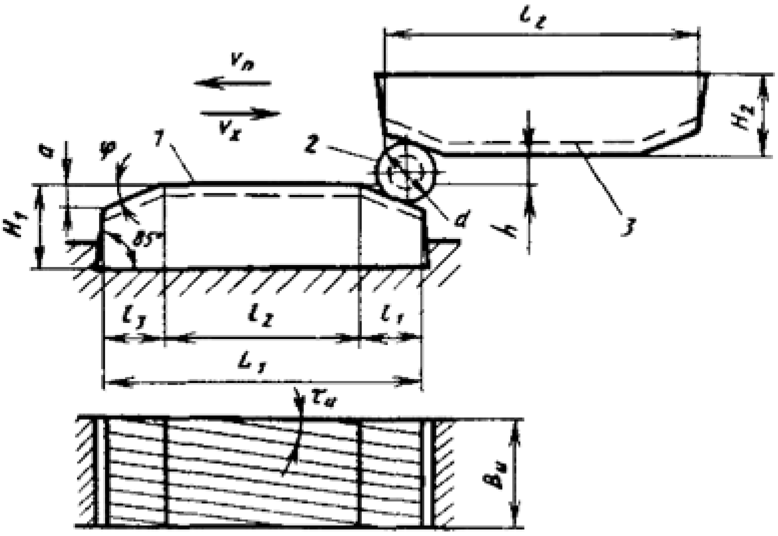


Figure 24 - Scheme of threading with flat dies

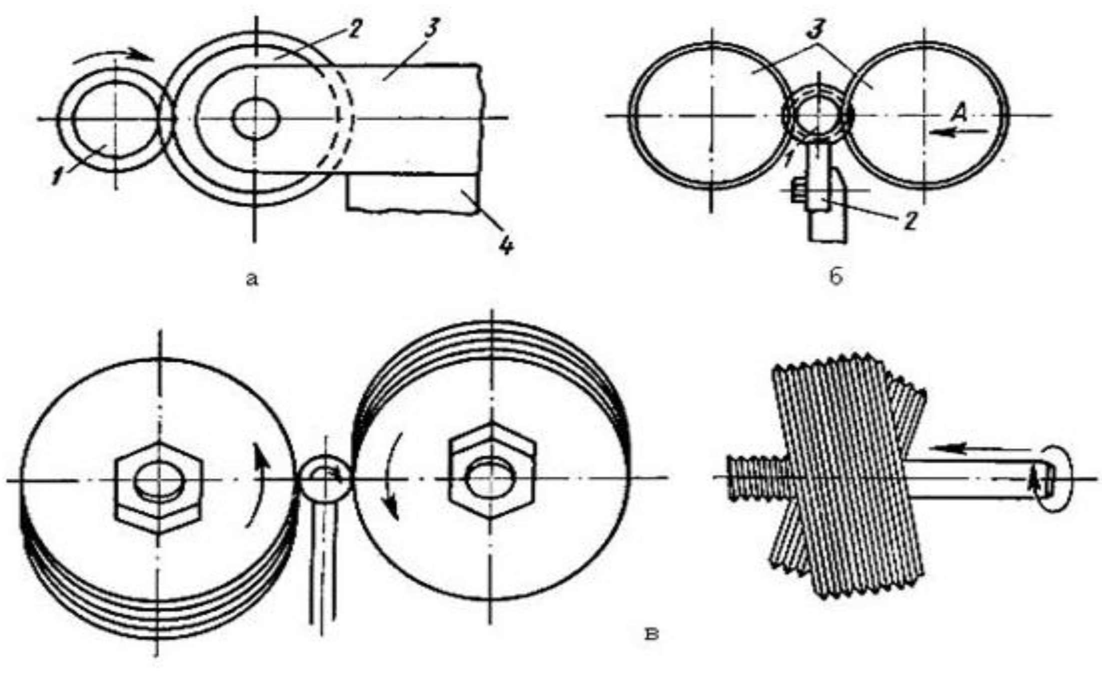


Figure 25 - Screw threading rollers:

a - one video; B - two rollers with spiral grooves; in - two rollers with ring grooves

When rolling the carving with one roller there is a deflection of the parts, which reduces the accuracy of the carving. In this connection, the carving of two carriages with screw or ring grooves became more widespread. In the first case, the axes of rollers and workpieces are parallel. In the second - inclined at an angle of lifting of the carving. When rolling the workpiece 1 is based on the bar 2. Both rollers 3 rotate in one direction. The work is carried out with regard to the rollers of the propeller movement.

Grinding a thread Grinding a thread on thread-grinding machines is used to handle tools, precision screws and other parts with precise threading. Grinding a carving is usually after heat treatment. One-threaded and multi-threaded circles are used for grinding.

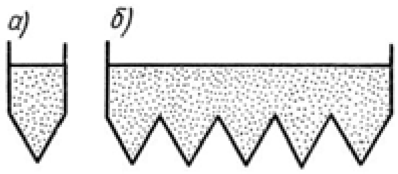


Figure 26 - Abrasive wheels for thread grinding:

a - one-sided; b - multi-pin

The process of polishing a single-thread thread and multi-threaded circle is similar to milling according to the disc or group cutter. Grinding a single-threaded circle 1 (Figure 2.50) is carried out with the longitudinal displacement of the part 2. This method allows you to get a thread of very high precision.

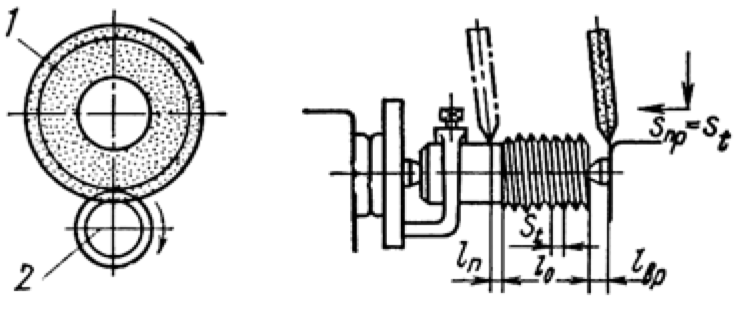


Figure 27 - Grinding thread with a single-threaded circle

Multi-threaded circles are used when grinding a thread on parts with a short cut-out part (usually no more than 40 mm).

Fig. 28 shows the grinding circuits of the multi-threaded circle. The width of the grinding wheel should be greater than the length of the polished carving for 2-4 steps. On a circle a ring carving with the necessary step is made. Grinding is done by the method of cutting with the longitudinal displacement of the part. If the length of the thread is greater than the width of the multi-circle, the grinding is carried out with the longitudinally moved parts relative to the circle (Fig. 28 b). All threads of the carving parts are consistently polished by all threads of the grinding wheel. Grinding a multi-threaded wheel is more productive, but the accuracy of the thread achieved by this method is lower than when working with a single-threaded circle.

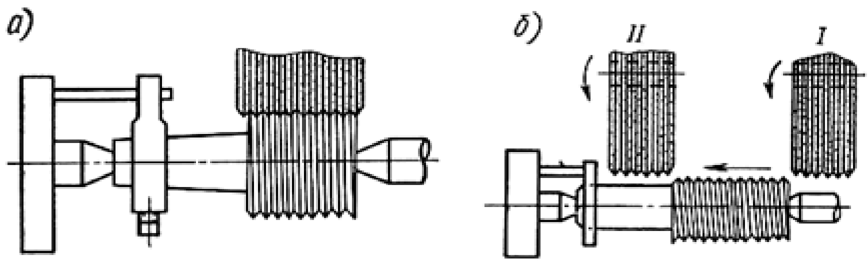


Figure 28 - Grinding thread in a multi-threaded circle:

a and b - grinding schemes; I and II - respectively the initial and final position of the grinding wheel

All threads of the carving parts are consistently polished by all threads of the grinding wheel. Grinding a multi-threaded wheel is more productive, but the accuracy of the thread achieved by this method is lower than when working with a single-threaded circle.

TASK

1. The main drawback of the dies?
2. Milling of external and internal thread is executed on thread-boring machines by?
3. Milling of short threads with a small step is carried out on?
4. Taps are used for?
5. The threading of the thread that carried out by plastic deformation is called?

4.TECHNOLOGY OF PROCESSING CASE PARTS

Body parts in most cases are basic parts, which are mounted individual assembly units and parts, which are interconnected with the necessary accuracy of the relative position (Fig. 29).

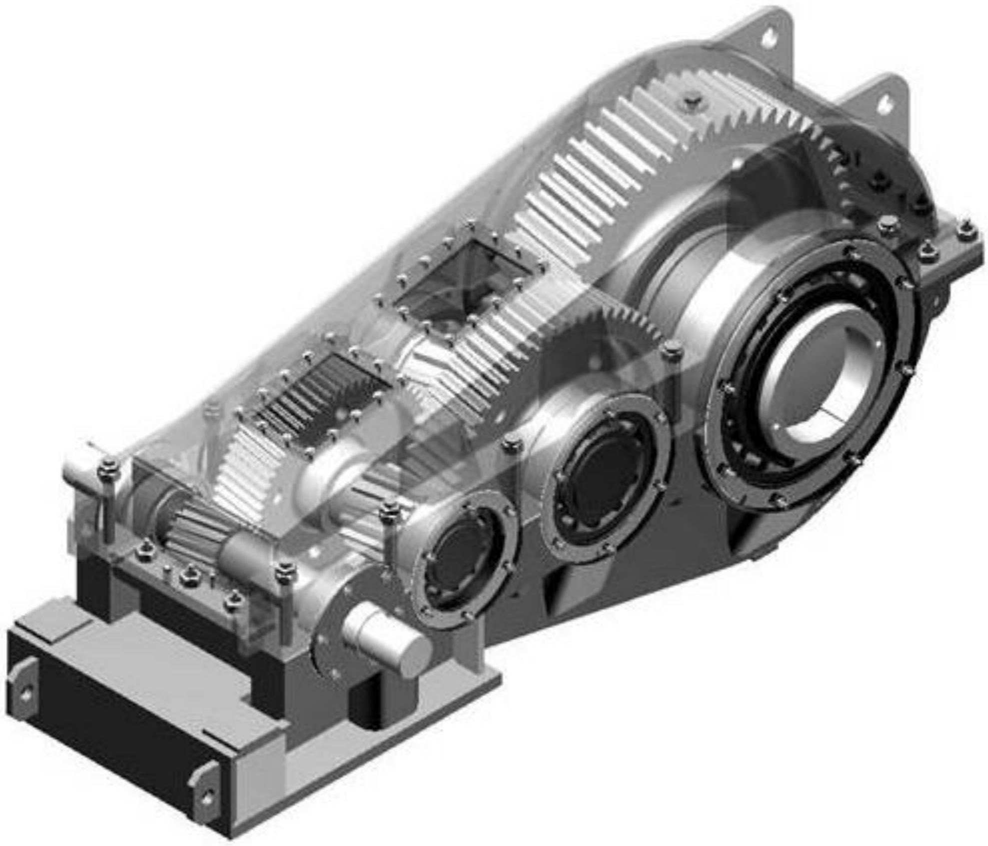


Figure 29 - An example of using the body part in the design of the gear unit

Body parts should ensure the accuracy of the relative position of parts and mechanisms both in the static state and in the operation of machines, as well as the smoothness of their work and the absence of vibration.

Classification of body parts. By official design and structural forms, body parts can be divided into the following main groups.

1- Case-shaped parts of box-type. They tend to have the shape of a parallelepiped with thin walls. All of their overall dimensions - values of one order. A characteristic feature of this group of parts is the presence of holes in them, which serve as support for shafts (Fig. 1). The diameters of the main holes (for mounting spindles, shafts, pins and their supports) are within the range of 20-540 mm. Box-type details may be indivisible and detachable to all or part of the openings and have internal partitions.

2- Casing parts with internal cylindrical surfaces: cylinder blocks, engine cylinders (fig. 2, are) and compressors. This group of parts has precise cylinder holes in size and shape, as well as holes for the installation of cranks and other shafts.

3- Case details of a complex spatial shape - cases of single centrifugal pumps, steam and gas turbines. The form of these parts provides the creation of smooth-flow channels for the flow of liquids and gases.

4- Carriages, slides, tables, stands, sliders, trunks, faceplates and other details which, in the process of operation, carry straight rectilinear or relative rotary motion.

5. Brackets, corners, racks.

6- Plates, covers, hoods, pallets, troughs.

Variety of body parts are shown in Figure 30

Technical requirements for body parts. For body parts, put forward technical requirements for durability, rigidity, wear resistance, accuracy, minimum deformations with a variable In relation to the accuracy of the processing to the body parts put forward the following basic requirements:

1 - the accuracy of the form of the base surfaces - the plane or straightness of the planes in the corresponding directions;

2 - the accuracy of the relative position of the flat base surfaces - in one plane, in parallel or perpendicular planes;

3 - accuracy of distances between axes of apertures or axes of holes and planes, coincidence of holes;

4 - parallelism or perpendicularity of axes of holes and planes.

Certain surface cleanliness requirements are also put forward on the surfaces of the body parts.

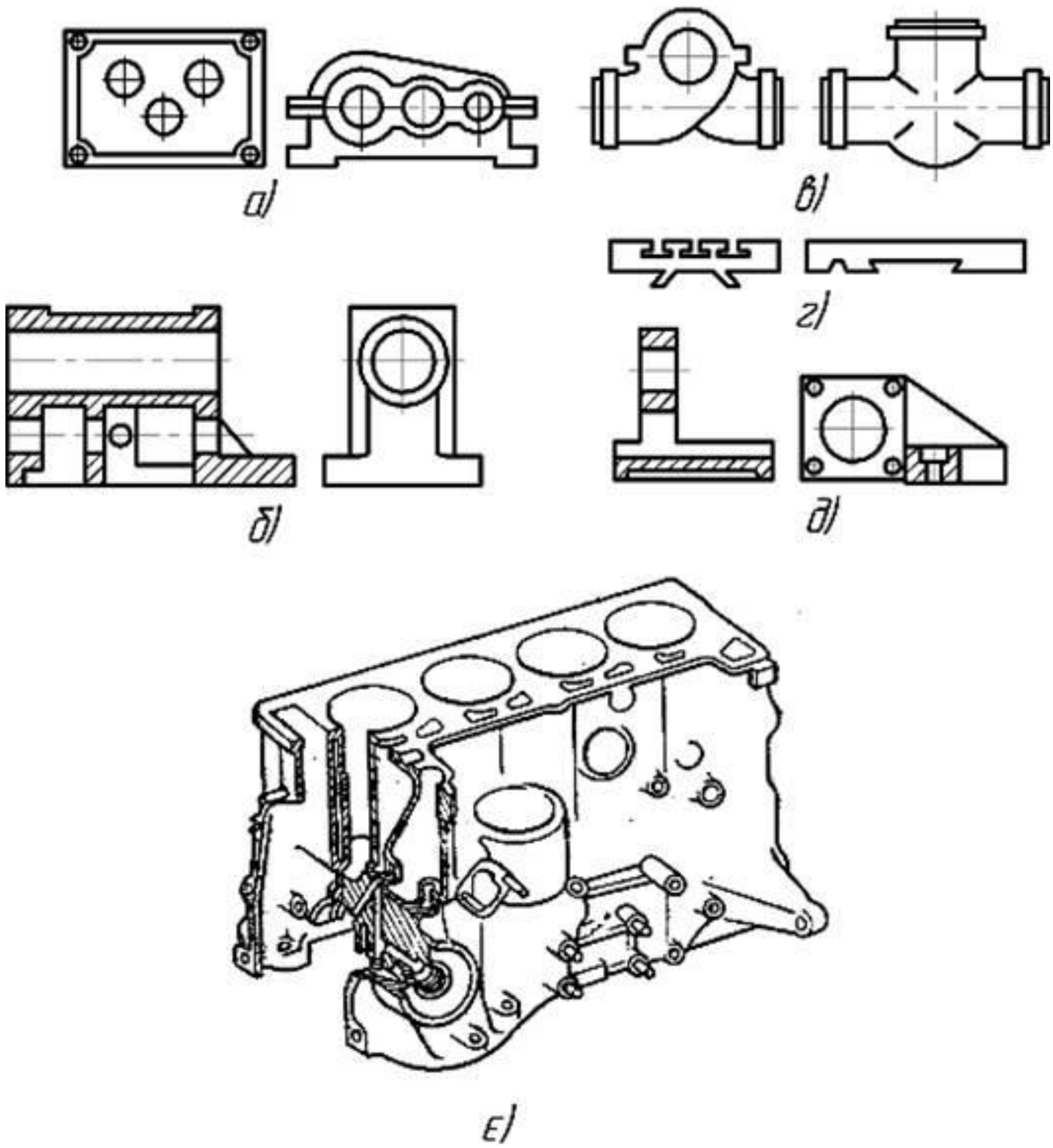


Figure 30 - Varieties of body parts: a-box-shaped; b-with long cavities; complex spatial formrm; D-type brackets, corners, covers; is a block of engine cylinders

The main holes for bearings are performed on 7 to 8 qualities with roughness Ra = 2.5 ... 0.25 μm, less than 6 qualities with roughness Ra = 0.63 ... 0.08 μm.

Insecurity of holes is allowed within half the tolerance to the diameter of the smaller aperture, and their conical and complex spatial form is not more than 0,3-0,5 fields of tolerance per diameter. The non-parallelism of the axes of the holes is 0,02-0,05 mm by 100 mm in length. Surface adherence is treated with roughness Ra = 6,3 ... 0,63 microns, and their deviations from straightness are allowed within 0,05-0,02 mm along the entire length.

Billets of body parts. Most of the body parts are made of gray iron and carbon steel, also used forging pig iron, alloy steels, alloys of non-ferrous metals. The main influence on the choice of brand material is the operating conditions of the body detail.

For the manufacture of body parts, gray cast iron is widely used, because it is a good constructive material, rather cheap and has good technological properties (liquid flow, machinability). Mechanical, physical, technological and other properties of pig iron can be changed within a fairly wide range, expanding the scope of this material.

Castings of gray cast iron, as a rule, are subjected to low temperature annealing to remove internal stresses, increase viscosity, prevent spalling and crack formation during machining and operation.

For welded body parts, in most cases, low-carbon steel (sheet stamps of grades V 3, V 4) are used.

Cases of steam turbines, which operate at temperatures of 250 - 400 ° C, are made of carbon steel of grade 30L. For steam turbines, which operate at temperatures of 400 - 500 ° C, molybdenum and chromium molybdenum steels are used.

Recently, more and more applications for the manufacture of body parts of machines are aluminum alloys.

The workpieces of body parts are made by casting or welding.

Molded billets are casting in a molding mixture, in a mold, in shell molds, under pressure, for fine and light details, casting is used on the smelting models.

Welded workpieces are obtained by cutting or stamping individual elements of sheet or profile rolling with successive welding.

Casting in the molding mix is the most common way of obtaining billets.

Manual molding is used for the production of castings in individual and serial production and in the manufacture of large parts. Molding in the ground is used mainly in individual production for the production of medium and large castings. Molding in foam is used in all cases where there is no need for paired flippers.

Machine forming on metal models are used for obtaining small and medium castings in mass production and mass production.

Casting in metal forms is used in serial and mass production for billets of non-ferrous alloys, iron and steel.

Casting under pressure is used for production of billets of non-ferrous alloys (zinc, magnesium, aluminum, copper). Pressed billets can be made of preforms of complex shape, shaped thin-walled with openings.

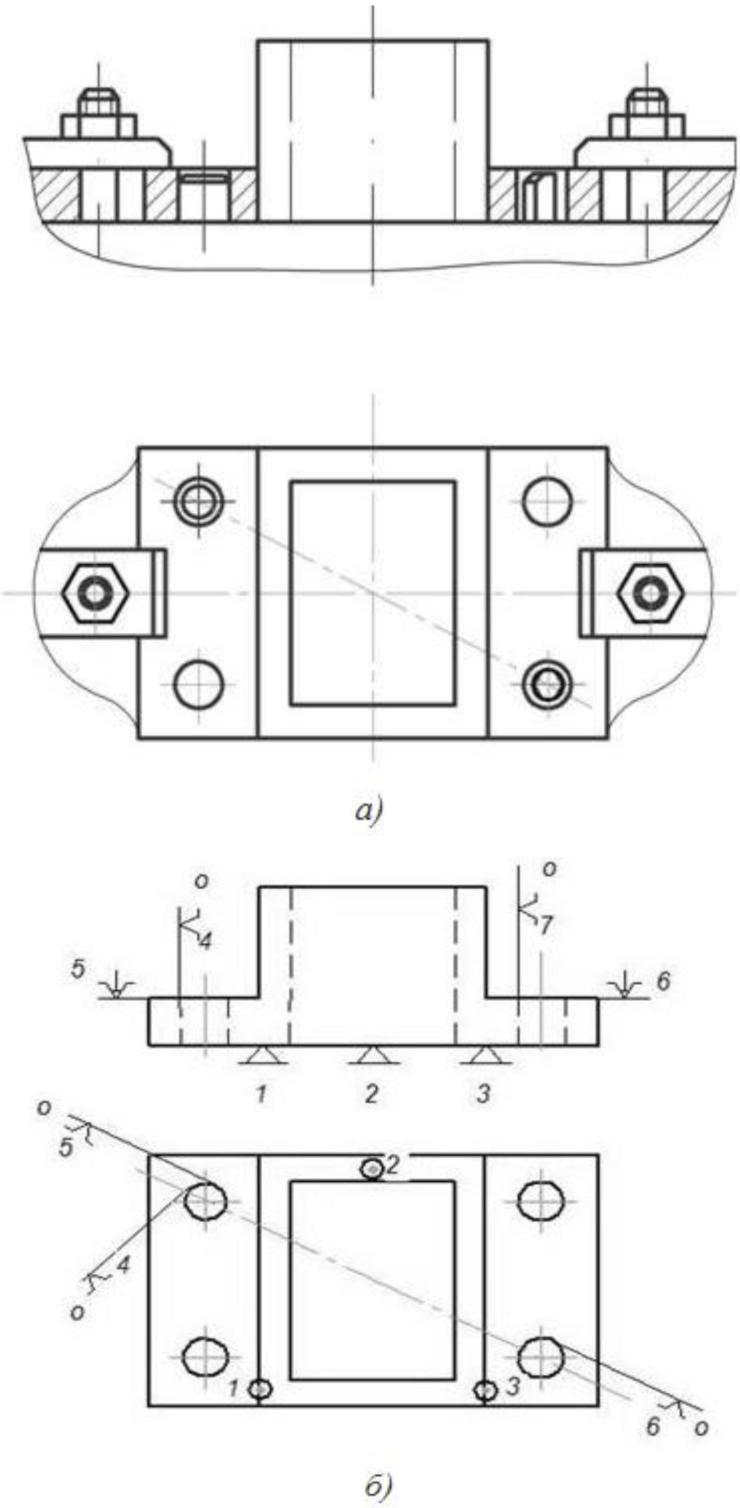


Figure 31 - Scheme of the base case bodywork component on the plane and two openings (a) and the theoretical scheme of the base (b)

The workpiece of the case is mounted with holes in the plane on two fingers, one of which is cylindrical, and the other is rhythmic (cut), with fingers placed diagonally.

a б)

Figure 32 - Setting fingers of gadgets; a-cut (rhombic) finger; b-cylindrical finger

The use of a cut finger allows the installation of workpieces in which the tolerance to the intercenter distance of the openings is greater than the tolerance to the inter centre distance for the fingers, which reduces the requirements for the accuracy of this size in the workpiece.

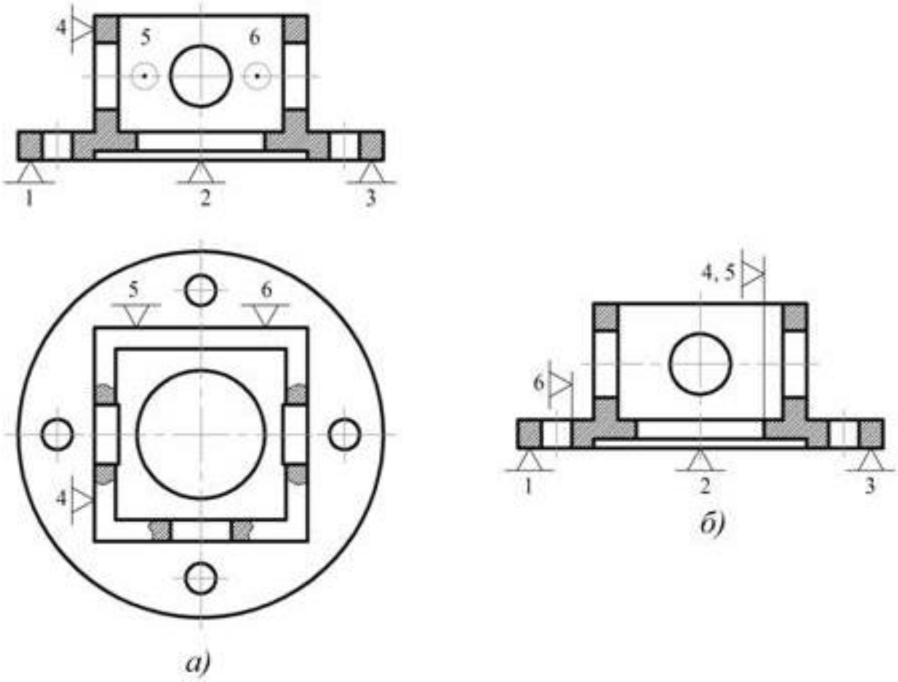


Figure 33 - Boxing-type housing frameworks; a-on three mutually perpendicular planes; b-by plane, small and large openings

Details with coaxial holes, in which, when boring on pre-adjusted machines, it is necessary to ensure a uniform removal of the drop, it is recommended to base on these openings, using them as rough bases. To do this, in the holes to the boring, inserts the tapered mandrels and the surfaces are treated, which are then used as a finishing base.

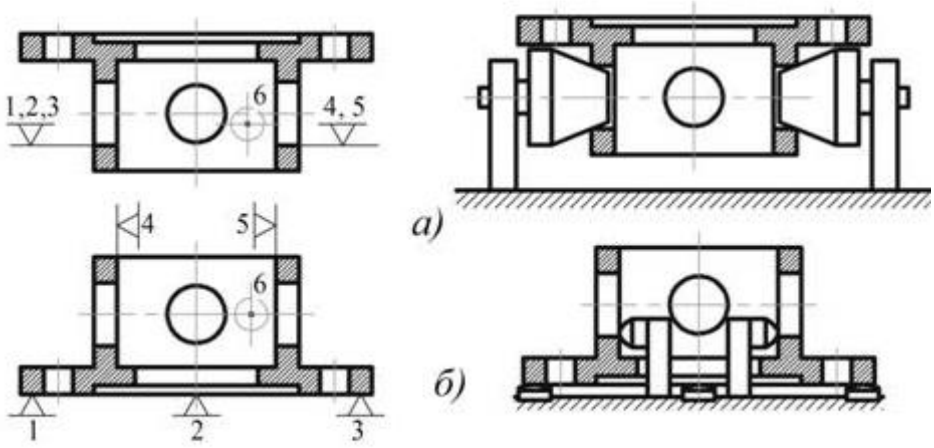


Figure 34 - Schemes for the base case parts of the box type: a-through the main openings; b-on the inner surface

The details of the flange type are based on the flange face 1, a hole 2 of larger diameter and a hole 3 of small diameter in the flange, but the distribution of the reference points depends on the ratio of the length of the base elements of the device (half-length of the base part of the hole to its diameter). Thus, when the flange type is based on a long stick, it is deprived of four degrees of freedom, and when based on a short yaw - two.

If the part has several main openings and they are of sufficiently large dimensions, then they are based on two unprocessed openings 1 and 2 with parallel axes, using cantilevered mandrels with retractable elements and perpendicular to them with a flat surface 3. In this setting, process the 4th and 5th planets. By installing the workpiece on these paving stones under subsequent processing, it is possible to ensure the removal of a uniform discharge during boring of the main openings.

When the part is unstable, or it is not sufficient for the installation of a flat surface, the parts make additional bases in the form of tides, bobies or tides with fitting holes.

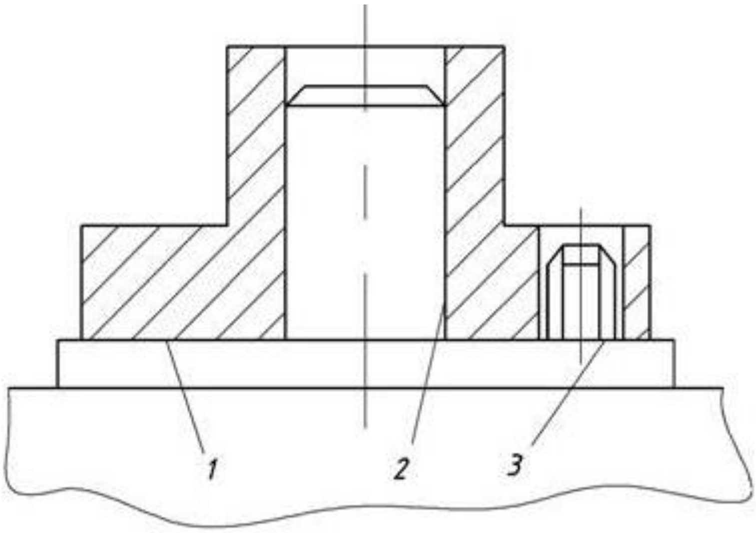


Figure 35 - Bundling of the flange-type body blank on the plane, long finger and hole of small diameter in the flange

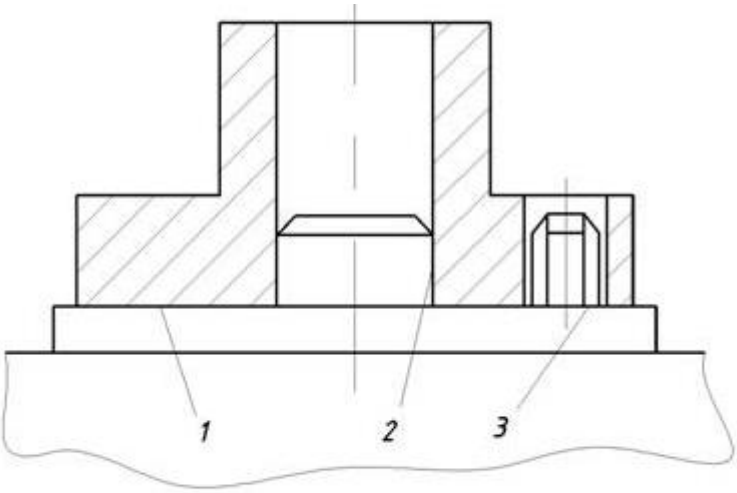


Figure 36 - Basing the workpiece of the flange type housing on the plane, a short hole and a hole

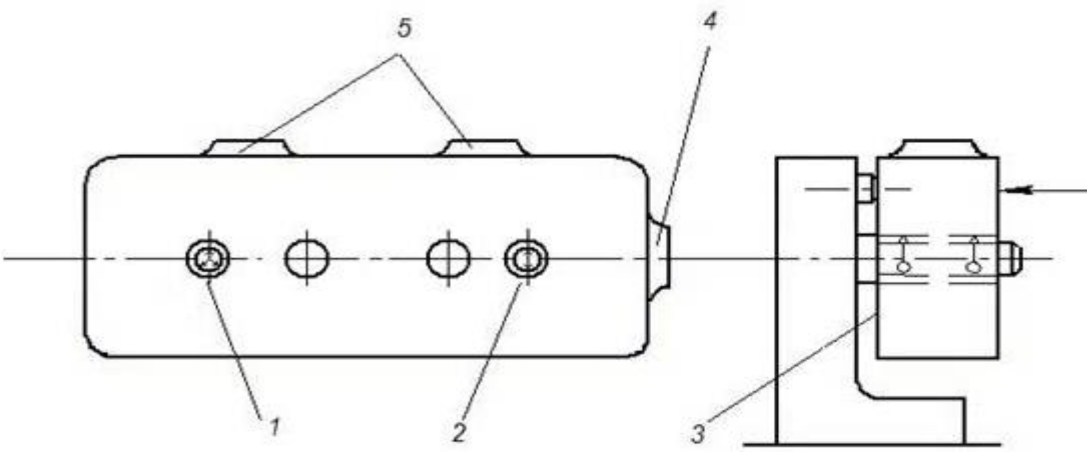


Figure 37 - Body shaping using cantilever chairs

The structure of the process of processing the workpieces of body parts. Operations of the technological process of processing billets of body parts are divided into main and secondary.

The main operations, in turn, can also be divided into two groups.

The first group - it is milling or planing, and if necessary, grinding of flat surfaces.

The second group is boring, deploying or grinding precise openings, which are interconnected by precise mid-distance distances.

Secondary operations are the drilling of inaccurate, small, lubricating holes, drilling and cutting of grooves in holes for fastening parts, forging holes, manufacturing various grooves, milling small platforms, etc.

The technological process of manufacturing the body detail includes:

1 - roughing and finishing of planes and openings used as technological bases;

2 - processing of the rest of the outer planes;

3 - rough, pure or semi-processed processing of main openings;

4 - final processing of the main bases and main planes and holes.

Technological route of processing of body parts is modified depending on the nature of the workpiece and accuracy requirements. So, in the case of processing a body detail that has a connector plane, the process involves:

1 - processing of the plane of the connector of the case;

3 - processing of base planes;

3 - drilling and cutting of the groove in the mounting holes along the plane of the housing connector, connection of the case with subsequent fixing of control pins, joint processing of the main planes and openings, etc.

TASK

1. Body parts are used for?
2. Classification of body parts?
3. Billets of body parts?

5. TECHNOLOGY OF PROCESSING OASES

The details of the "Legs" class include levers, rocker arms, dogs, leashes, handles, harnesses. Schematic sketches of different levers are shown in Fig. 38

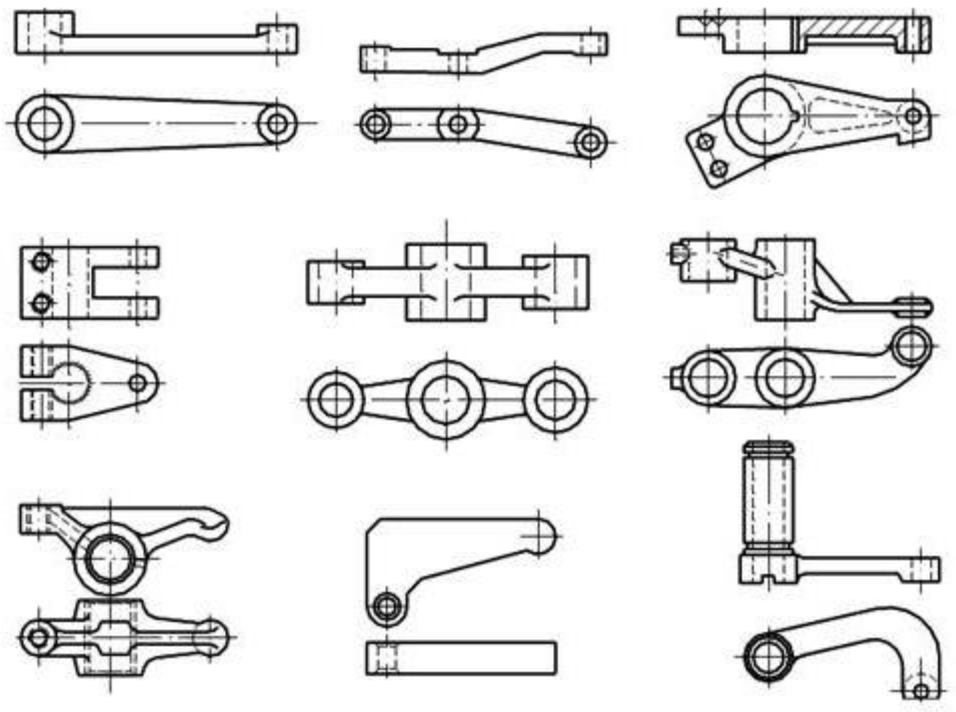


Figure 38 - Details of type of levers

Levers are links of systems of machines, devices, devices, devices. With oscillating or rotary motion, the levers transmit the necessary forces and movements to the conjugated parts, forcing them to carry out the necessary movements at an appropriate speed. In other cases, levers, for example, fasten, remain stationary and fix the relative position of the conjugated parts.

Details of the class of levers have two holes or more, whose axes are arranged in parallel or at right angles. The body of the levers is a rod that does not have sufficient rigidity. In the details of this class, in addition to the main openings, are processed side or slot surfaces, fasteners and slots in the heads. The rod levers are often not treated.

A significant variety of construction of the levers causes the need for their classification in order to narrow the typical technological processes. To this end, the following classification is recommended:

1. levers in which the ends of the openings have a common plane or their ends are in the same plane;

2. levers in which the ends of the openings lie in different planes;

3. levers, which have a long sleeve with a hole and considerably shorter sleeves.

One of the main bases of the lever is usually the hole surface, which in most of the lever designs is a dual guide base, which lever joins the base component. In the complex of auxiliary bases in most of the levers there are surfaces of smooth openings, which are parallel to the main base, and less than the surface of the threaded or smooth openings perpendicular to it.

In some of the instruments (valve armor, ratchet dogs), in most cases, the performing surfaces have curvilinear surfaces, with which the mechanism performs its official purpose.

Forks in mechanical engineering are called parts, which have two different official purposes, in connection with what they are further divided into two types.

The first type includes switching forks, which, when axial displacement, switches gears, couplings and similar kinematic links of machines. Schematic sketches of typical switching plugs.

The switching parts are moved by the forks mainly by means of executing, in most cases flat, surfaces. Depending on the specific service purpose, the switching switches are slightly different in appearance, which can be divided into flat and long-drawn forks with more advanced bobies of the type of sleeves. The main double guide base in the switch fork is the hole surface.

When moving the plug with the switching component, a moment is created that tries to turn the plug and to skew it relative to the roller and moving parts, due to a gap in the opening. To reduce this distortion, the main dual guide base, even in the fork, should have a sufficiently large bobbin length and an exact diameter of the hole.

For the second type include forks, for intermediate parts of hinged joints in cars - joints. In order to perform their official appointment, they usually have ears with two coaxial smooth openings, the combination of which provides an auxiliary dual guide base forks. The main dual guide base of the fork is the surface of the chopped hole in the shaft or the smooth cylindrical or chopped outer surface of the shank of the fork.

The length of the levers and forks in secondary processing, textile machinery, automobiles, tractors and other machines in most cases does not exceed the following dimensions: levers - 400 mm forks switch - 250 mm, hinged forks, 120 mm.

Specifications that determine the official purpose of the levers and forks, are characterized by many indicators, of which the most significant can be considered the following.

Accuracy of sizes. Openings - basic and auxiliary base surfaces which levers and forks with rollers, levers and design of articulated forks for H7, H9, and the forks switched to reduce distortion when axial displacement - for H7, H8. The accuracy of the distances between parallel-carrying surfaces of switching forks is assigned to IT10 - IT12. The distance between the axes of the openings of the main and auxiliary levers must be in line with the calculation; permissible deviations depending on the required accuracy vary from ± 0,025 to + 0,1 mm

Form accuracy. In most cases, special requirements for precision surface shape is not put forward, that the error form should not exceed the size of tolerance or, depending on the conditions, errors of form should not exceed 40 to 60% of the tolerance field for the corresponding Font.

Accuracy of mutual arrangement. For good adhesion surface holes to conjugate parts axis surface openings auxiliary bases levers should be parallel to the axis of the hole surface of the main bases permissible deviations (0.05 ... 0.3) / 100 mm.

In the levers that have a flat surface treated, in some cases (for official purpose) is set perpendicular axes relative to these planes holes with a tolerance (0.1 ... 0.3) / 100.

The quality of the surface layer. Roughness holes in the levers and forks according to the diameter of the hole exactly prescribed Ra = 0.8 ... 3.2 mm, the roughness of surfaces performing levers Ra = 0.63 ... 3.1 mm, the shift forks - 0 8 ... 3.2 μm. To increase the service life, the hardness of the carrying surfaces of the levers and forks is set by NRS 40 ... 60.

Materials and workpieces for levers and plugs. As materials for the manufacture of levers are: gray iron grades from МЧ 15 to СЧ 24, malleable cast iron of grades КВ 35-10, КЧ 37-12, etc., ordinary grade grade 5 steel and constructional grades of grades 20, 35, 45, 40X . Levers operating at low loads are made of plastics.

Flat switching forks are made of gray and malleable iron and steel, approximately the same brands used in the manufacture of levers. For the manufacture of longitudinal switching forks, gray cast iron of the same brands as for levers is usually used. The fork joints are made of steel of the usual quality and of structural steel grades 35, 45 and others.

The choice of material depends on the purpose of the service and the cost-effectiveness of the manufacturing of the part. Forks and forks of a complex form can be made with a sufficiently economical workpiece - castings. For parts working in machines under small, non-shock loads, less expensive and durable gray cast iron grades from МЧ 15 to МЧ-18 are selected. The details, working at more heavy loads, are made from more durable and expensive pig iron brands СЧ 21 and МЧ 24. For non-rigid parts working with impulses and impacts, insufficiently loaded gray cast iron is unreliable material and is replaced by malleable cast iron. When getting malleable cast iron it becomes obligatory to anneal, after which non-rigid billets are broken and must additionally be subject to stamping. The introduction of additional annealing and adjusting operations makes the workpiece more expensive, so in some cases the levers and forks are made of steel.

Cast iron workpieces of levers and forks are usually cast in sand form, formed predominantly on machines by metal models. With increased requirements for precision billet castings are cast into shell forms. Castings of malleable cast iron should be annealed and the next straw to reduce remaining deformations.

Castings of flat forks are composed of two or even three parts.

Accepts for processing and tolerances on the sizes of castings of levers and forks must be in accordance with GOST 26645-85. Steel workpieces of levers and forks are obtained by forging, stamping, casting on smelted models and less welded. When stamping billets in small quantities apply molded stamps. With the increase in the scale of production of billets, it becomes more economical to punch them in open and closed stamps. In serial production stamping is performed on stamping hammers, friction and crank presses, and in large-scale and mass production-on crank presses and horizontally-forging machines. In order to increase productivity and reduce the cost of stamped billets, their pre-formation in mass production in some cases is made on the forging rollers.

Additions to the processing and tolerances on the size of the workpieces of the levers and plugs obtained in open stamps must not be larger than specified in GOST 7505-89.

To improve the accuracy of stamped blanks of flat forks and in some cases, levers in mass and large-scale production use calibration and molding.

Calibration is an additional stamping on stamping hammers, friction and crank presses, and is performed to avoid excessive scaling from one heating immediately after cutting the burrs.

Embossing - cold stamping in special stamps and, of course, on special molding presses, executed after heat treatment (normalization, annealing or tempering with release) of blanks and clearing them from scale. The accuracy of the distance between the surfaces of the billets after mending can be obtained within ± 0,08 mm to ± 0,2 mm.

In order to reduce labor-intensive mechanical processing, reduce the cost of metal and improve the appearance of complex structural shapes steel levers and forks, their workpieces, instead of forging or stamping, are cast by casting models. The models of the billets and the borehole system are made of low melting model mixtures prepared on the basis of paraffin, polystyrene, stearin and similar components, and obtained in special molds.

The roughness of the surface of the casting on the melting patterns corresponds to Rz 20.

Tolerances on the dimensions and assumptions for the treatment of casting of levers and forks on the casting models are given in the relevant reference books. In all cases, the tolerances on the dimensions and tolerances for the treatment of castings on the casting models of levers and forks must not exceed the values specified in the GOST for casting of the 1st grade.

The high cost of casting for casting models in comparison with other methods of obtaining billets limits the scope of its application. Therefore, the method of obtaining workpieces of levers and plugs should be selected on the basis of a technical and economic comparison of technological options, taking into account the cost of obtaining billets and the subsequent machining of parts.

Holes with a diameter of less than 25 mm, in blanks obtained by casting in sand forms and stamping, usually do not get. Casting on smelted models more economically to receive smaller openings.

Steel levers and forks with steel operating at high load to increase strength before machining heat-treated (quenching and tempering high).

Treatment of levers and plugs.Analysis of the details drawings and specifications to be met by instruments for performing official designation shows that the surface holes (auxiliary base) and performing surface levers must take definite position relative to the surface holes (fixed base); the ends of the bobies, the holes for the fixing screws and the pins must be perpendicular, and the slots are parallel to the axes of the corresponding openings; the grooves of the plucked levers in most should be perpendicular to the axes of the openings-the main bases.

To obtain the indicated bonding surfaces, the processing of the levers is constructed in the following sequence:

1. In the presence of levers of flat working sides or ends of bobs in one plane, first these surfaces are treated. Then, taking the treated plane or combining the ends of the bobs from one side as an installation technological base, process the openings, the main and auxiliary bases, obtaining the appropriate necessary connections. In subsequent operations, taking appropriate surface treatment holes as technological bases, create the necessary connections of other processed surfaces of the lever, consistently processing the grooves, ledges, threaded and small openings.

2. When handling levers with ends of short bobs in different planes, in some cases, smooth openings-the main and auxiliary bases and ends of the bobies on one

side are treated in a number of cases. Then the ends of the bobies are processed on the other side, further-the other surfaces in the sequence indicated in the first variant.

3. If the boss has a long arm, which is opening (the main base) and much shorter boss, which are holes (auxiliary base), the first hole-treated surface of the main base and the long end boss on one side. Then, taking the treated surface of the hole as a guide dual technology base, long handle end boss on the other side and, if necessary, external cylindrical surface long boss. Then, to obtain the appropriate bonds, the surface of the holes (auxiliary bases) and the ends of the short bobies on one side, and then the ends of the bobies on the other side, are treated. Next, the other surfaces are treated in the order indicated in the first embodiment.

Depending on the specific conditions, the sequence of processing the surfaces of the levers may vary slightly in relation to the resulted typical schemes. For example, using the second option ends milling, processing them to handle holes in the processing of instruments with short Bosses initially treated surface hole (main base), and then the next operation surface holes (auxiliary base) lever. This sequence in particular cases reasonable economy achieve precision surface holes - auxiliary bases - separately from the processing surface hole - the main base, such as surface finishing hole (home base) for aggregate lever machine or group using appropriate devices.

If the levers have executable surfaces, then they are usually first processed before processing the main base of the lever, and then finally at the end of the process.

When machining the flat side faces of the ends of the bobies of the levers in the first operation for the establishment of the technological base accept the opposite flat surface of the rod or the combination of ends of the bobies. The guide and reference base are chosen from the convenience of installing the part. When processing smooth holes (main and auxiliary base) with short lever boss by setting technological base also take the opposite flat surface or a combination of rod ends bobyshok arm and guiding and supporting technological base is usually chosen to provide the necessary alignment with respective openings boss.

The choice of the basis for a particular lever depends on the task posed by the technical condition. By displaying the technical condition of the original link of the dimensional circuit and constructing a dimensional chain, one can calculate the tolerances on the components of the links of the dimensional chain. The tolerance to the inaccuracy of the output link should be less than the specified technical condition, because the part of the admission of the technical condition must be reserved for compensation of the inaccuracies caused by fixing the part in the adaptation and inaccuracies of the dynamic balancing of the VPS system.

To identify features and evaluate the presented options, it is advisable to compare them, defining the tolerances on the components of the links of the dimensional chain, based on the limit deviations of its closing link. For a more accurate comparison of options, one can restrict itself to considering only those deviations that. caused by the inaccuracy of basing the workpiece and coordinating the instrument. Then the locking link will be obtained at each variant of the inequality of the tool and the bobies of the lever preparation.

TASK

1. The details "Legs" are used for?
2. Levers are?
3. The classification of levers?

6.TECHNOLOGY OF CYLINDRICAL GEARS PROCESSING

Service purpose and typical designs of gear wheels. Cylindrical gears serve for the transfer of rotational motion between shafts with parallel axles and crossed axles (Fig. 39).

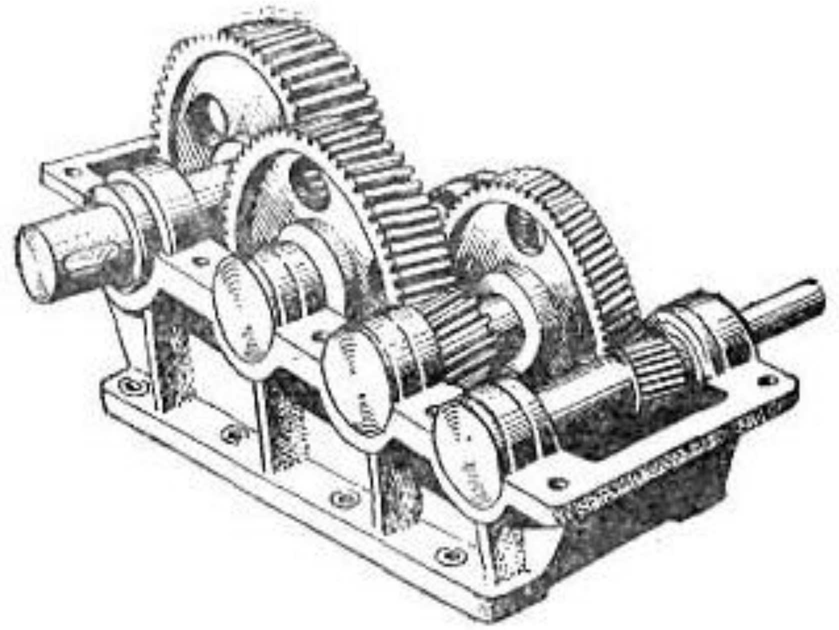


Figure 39 - Gear wheels in assembly

Distinguish power gear transmissions, serving for the transmission of torque with a change in the rotational speed of the shafts and kinematic transmissions, which are designed to accurately transfer the rotary movement between the shafts at small torque values. Cylindrical gears are made with straight, oblique and chevron teeth. In the gear transmission with cross-axes used wheels with screw teeth.

The main mechanisms in which cylindrical gears are used are the gearboxes of tractors, cars, and machine tools.

By design, cylindrical gears are divided into five main types: I - single-ended wheels with a sufficiently large length of the seat; II - multi-wind wheels; III - single-wheel drive type wheels; IV - crowns, which are made separately and then connected to the harness; V - wheels - shafts (shaft - gears).

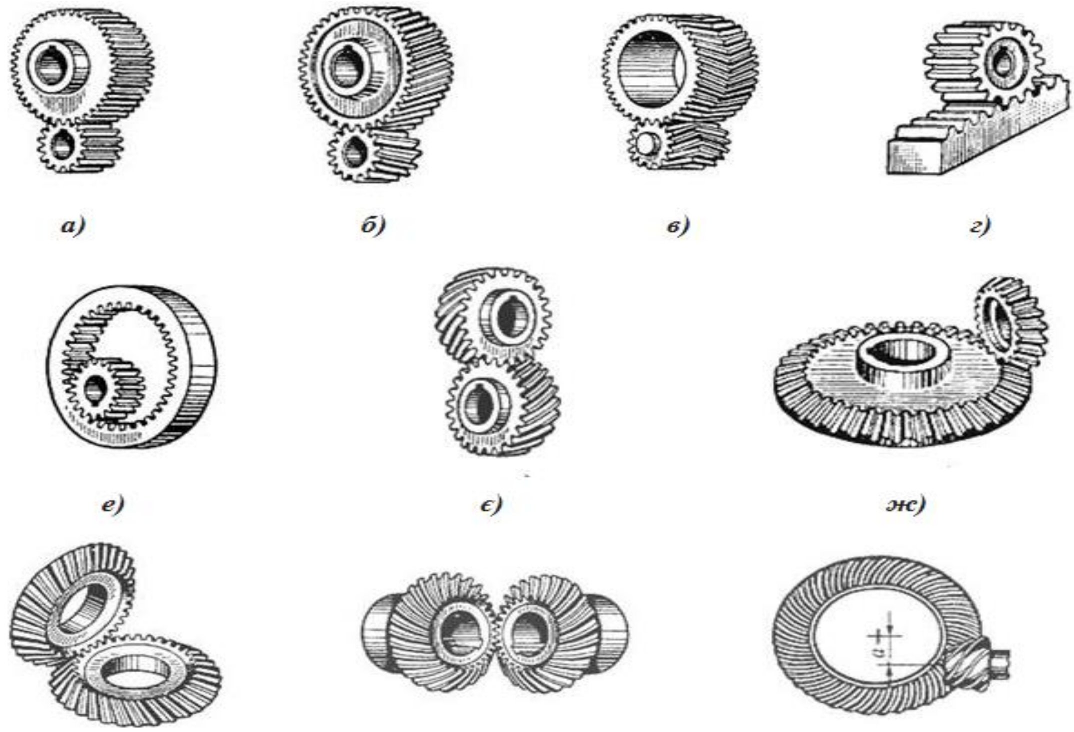


Figure 40 - Types of toothed gears: a, b, c-cylindrical gears with external engagement; g-rail transmission; D-cylinder transmission with internal engagement; e-gear screw transmission; g, c, and-conical gears; i -hypoyid transmission

Requirements for the accuracy of the production of gear wheels. The precision of gear wheels significantly affects the level of noise in the transmission, smoothness and durability of its work. The main indicators of the accuracy of gear wheels are:

Kinematic accuracy - characterized by the error of the angle of rotation of the wheel for one turning gear and is associated with the accumulated error step. It is important for mechanisms where the accuracy of the transmission ratio is required.

Smoothness of work - is characterized by fluctuations in the speed of rotation of the wheel with a uniform rotation of gears within one revolution. Linked to the mistakes of the step and the profile of the teeth. Affects dynamic loads and noise when transmitting.

The contact point of the teeth - the size of the spot affects the value of the contact stresses on the lateral surface of the teeth. Affects the durability of the transmission.

The side clearance is characterized by the free rotation of the wheels without jamming of the teeth. This gap is important for reversing gears, as well as for those working at high temperatures.

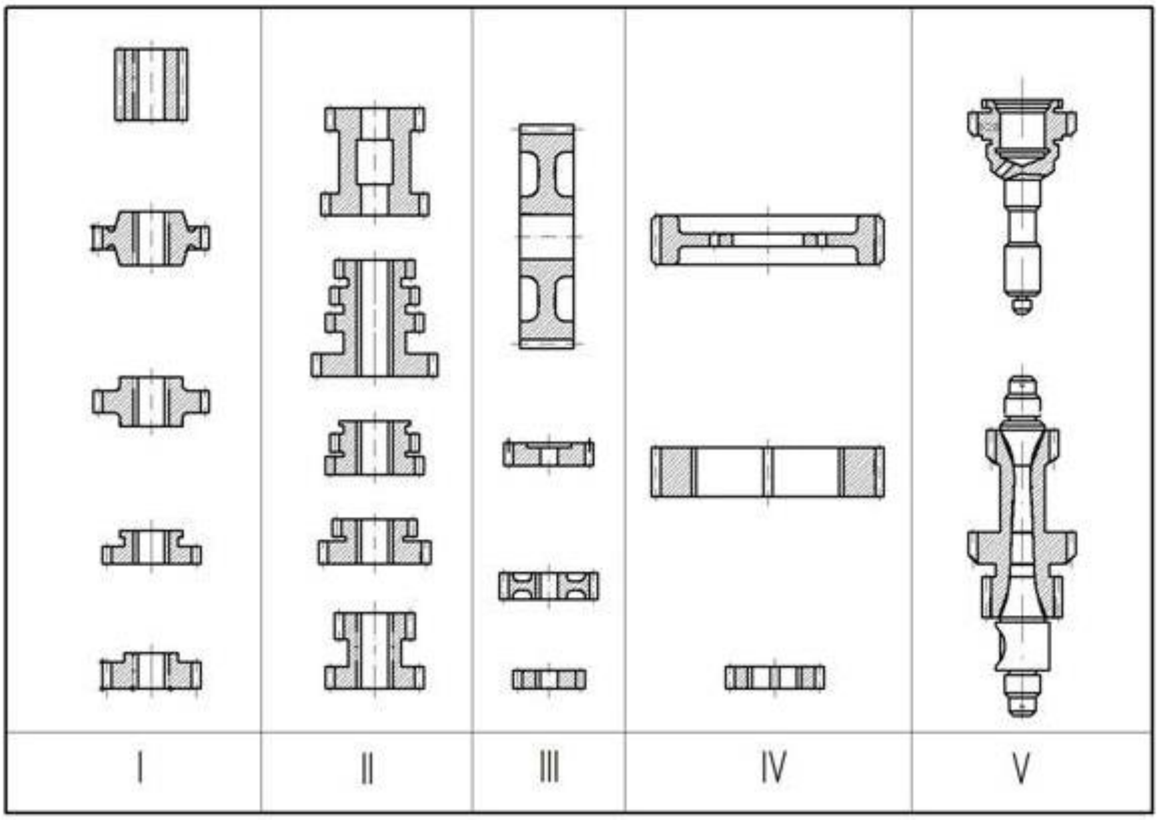


Figure 41 - Typical constructions of cylindrical gear wheels

In accordance with ГОСТ 1643 - 81 there are 12 degrees of accuracy of gear wheels (in order of accuracy): from 1 to 12. For degrees of accuracy 1 and 2 tolerances are not specified in the standard. They are foreseen for further development, so as not to enter as in other standards the notation with zero (0 or 01).

The most widely used in mechanical engineering are wheels of 6 - 8th degree of accuracy. In instrument making and machine tools, wheels of the fifth degree of precision are used. In open gears, wheels of the 9th degree of precision are used.

Regardless of the accuracy of the standard, the norms of accuracy for the lateral clearance, which are indicated in order of magnitude: N, E, D, C, B, A., are established. The gap in the combination H is minimal and equal to zero. It is usually recommended to combine B.

The precision of gear wheels in power transmission gears is chosen depending on the speed of rotation, and the accuracy of gear wheels in kinematic gears is chosen depending on the purpose of these gears. For precise gear wheels the end and radial beats are also normalized. The seating hole is performed on the 7th qualification, and for precision wheels of 5-6th qualification.

Material and heat treatment of gear wheels.The main materials for gear wheels are carbon and alloy steels, which are thermally reinforced to high hardness, grades 45, 20X, 40X, 40XH, 35XM, and others.

Thermal treatment is used to increase the hardness of teeth. With increased hardness, the bearing capacity of transmissions and contact strength increases. Therefore, quenching is used to increase the hardness of teeth in powertrains. In the kinematic gears intended for accurate transfer of rotational motion between the shafts at low torque values, the gears are not subjected to quenching. The main types of reinforcing thermal processing of gear wheels are following.

1. Volume hardening is the simplest method of heat treatment of the wheels. To his disadvantages it is necessary to attribute a high material flutter, which reduces the resistance of fatigue material when bending teeth.

2. Surface hardening provides high hardness of the surface of the teeth with a viscous core. The heating of wheels under superficial tempering is carried out in the inductor by high-frequency currents (microwave).

3. Chemical-thermal treatment (CTT) consists in saturation of a metal surface with various chemical elements. At present, the following types of CTT are used:

3.1. Cementation - saturation of steel with carbon with subsequent quenching. Provides high hardness of the surface of the teeth with a viscous core. For cementation, alloyed steels with low carbon content are used: 20X, 12XN3A, 20XHM, 15XΦ, and others.

3.2. Nitration - the saturation of steel with nitrogen, provides high hardness of the surface of the teeth without further quenching. Nitrogen is subjected to 38X2MUA, 40HFA, 40XNA, and the like. Teeth after nitriding do not polish. In this regard, nitration is used to strengthen the wheels of geared gears with internal engagement.

The disadvantage of nitriding is the length of the process (up to 60 h.) And the thickness of the strengthening layer (up to 0.5 mm).

3.3. Nitro cementation - saturation became carbon and nitrogen with the subsequent garment proceeds at higher diffusion rates (up to 0.1 mm / h). Steels for this type of HTS are 40X, 18XGT and so forth.

For wheels of large diameter, casting steels are used: steel 35 - 55L, 40XL, 30ХГСЛ, and others. Molded wheels are normalized.

For the manufacture of toothed wheels, open-speed low-speed gears are used for the front wheels. Cast iron show good resistance to jamming. Therefore, cast iron gears can operate without lubrication. For the manufacture of cast iron wheels are used gray cast iron grades СЧ25 - СЧ45, as well as high-strength pig-iron with spherical form of graphite.

Methods of obtaining billets. Blanks for toothed wheels in small-scale production are made from rolled metal or free forging. In large - mass production and mass production - stamping on hammers, presses and horizontally - forging machines (HFM). The metal is heated to a temperature of 1200 - 1300 degrees before forging and stamping.

Billets for hire. Rolled billets are cut from the bar for a given size. The maximum diameter of the rolled metal industry is 250 mm. Therefore, the diameter of the tops of the teeth should not exceed this size.

Billets, obtained by metal working pressure. Free forging is carried out on hammers or presses between flat-parallel plates. This method allows you to receive billets with a diameter of more than 250 mm. However, the shape of the workpiece is only close to the profile of the toothed wheel. To reduce the complexity of machining in large billets sew the embankment. When machining billets, obtained from rolled metal and free forging, the expense ratio of metal is the highest compared to stamped billets.

Punching on presses or hammers for workpieces for toothed wheels is carried out in lining or fixed stamps. Preparation in molded stamps are deformed from the end. The fixed stamps can be closed or open . In the open dies in the plane of the connector formed oblique, which is then removed in the circumcision stamps in a cold or hot state. In closed stamps a face oblique is formed, which is removed by rolling. Punching in fixed stamps is carried out from the end when the connector of the die is perpendicular to the workpiece axis, or along the axis when the punch connector is parallel.

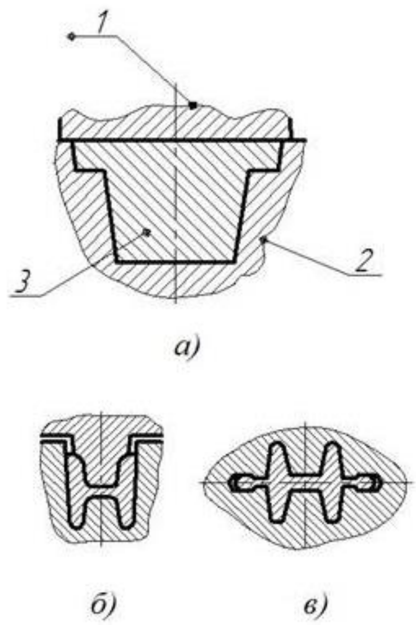


Figure 42 - Stamping schemes: a - in molded stamps; b - in closed; in - open; 1 - punch (moving part of the stamp); 2 - matrix (fixed part of the stamp); 3 - stamped workpiece

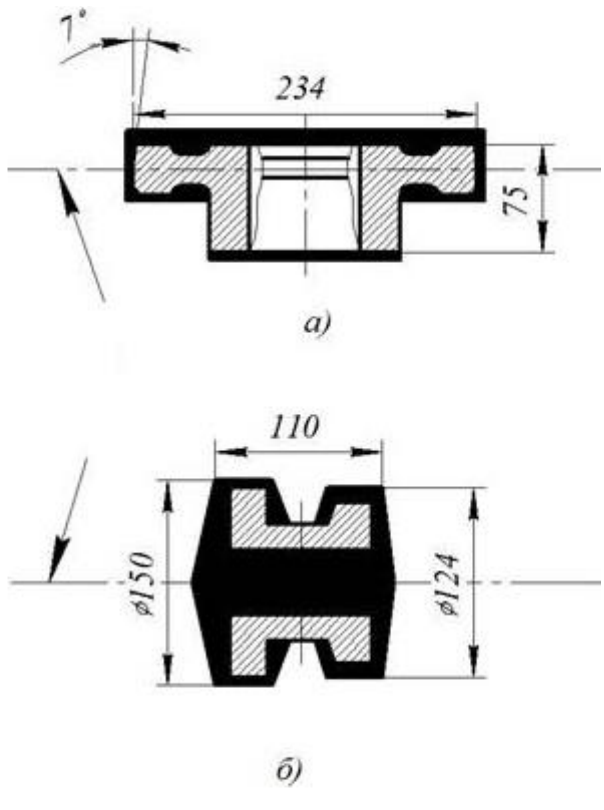


Figure 43 - Stamped workpieces for toothed wheels:

a - in the other side; b - along the axis

Punching (dismounting) on HFM receive billets from bars for blocks of gear wheels or gears - that is, when the workpieces have sections with a large diameter difference. The GCM matrix has a connector. One part of the matrix is mobile, the other is immobile. The punch at the landing moves horizontally. Punching is carried out in the following order: I - the rod is laid in a split matrix to the stop; II - the emphasis is given, the bar is pressed in the matrix and deformed by a punch; III - the deformation process is over, IV - the moving part of the matrix - the punch is diverted to the original position, the pouring out of the stamp.

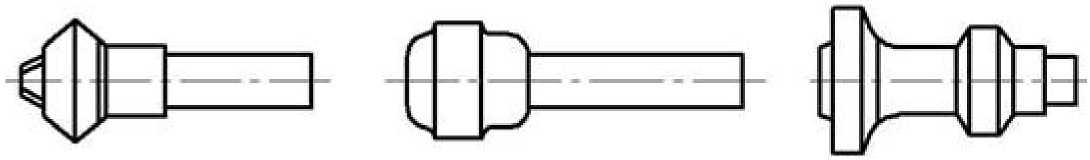


Figure 44 - Preparations for the gear wheels, obtained on the HFM

Basis of gear wheels in machining. The task of the base of gear wheels during machining is to ensure the alignment of the dividing wheel and the landing surfaces (central hole of the wheel or shaft nuts - gears). From this, the following parameters of the accuracy of gear wheels and transmission, such as axis distance fluctuations, lateral clearance and radial beating of the toothed crown, depend on it.

The basic surfaces of the gears in most machining operations (turning, tooth-shaped, and zebra) are end surfaces and a landing (central) hole that can be smooth with a groove under the key, splice or profile contour. These surfaces are processed precisely in the first place.

The tensile strength of shafts with profile contour is five times higher than the strength of the spline and pin joints due to the reduction of stress concentration, while the cost of manufacturing is reduced by two times.

The base surfaces of gear-type wheels of the type of shafts are center holes. The processing of these parts begins with the milling of the ends and the drilling of the center openings.

The structure of the technological process in the treatment of cylindrical gear wheels. The technology of manufacturing toothed wheels depends on the following factors: release program, construction, size, method of obtaining billets, material, accuracy and heat treatment. The main factors are the accuracy and design of gear wheels.

A typical technological process for the manufacture of gear wheels includes the manufacture of punches or forgings, turning of external surfaces and ends; treatment of the central opening, tooth-cutter, thermal treatment, finishing and finishing operations of the base and gear surfaces. The peculiarity of the technological process of manufacturing toothed wheels - shafts is the presence of operations for the treatment of teeth, and in the rest it is the same as in the manufacture of step shafts.

Processing of pre-cut before teeth. Turning of gears of toothed wheels. In the small-scale production of gear wheels for cutting teeth are processed on universal turning and screw-threading and turning-turning machines. The scheme of technological adjustment for processing a gear on a lathe-revolving machine.

When processing the part is clamped in a three-cap self-centering cartridge. In position 1 of the revolver head, the two blades sharpen the outer surface of the workpiece. At the same time, one cutter grinds the inner surface, another incision removes the inner chamfer. After removing the revolving armor, the two incisors B cut the ends with the cross support. In position 2 of the revolver head, the wide end plates are trimmed with an internal end face. Cutter A transverse carriage removes the chamfer on the outer surface. In position 3 of the revolving head, a central hole is drilled. In position 4, with the help of a special device, cut the inner groove. In the positions 5 and 6 of the revolving head, the central hole is rolled out by roughing and finishing rotations.

In large-scale production, the gears are machined on turning and turning-revolving machine tools with CNC models 16К20Ф3, 16К30Ф305, 16К20Т1, 1В340Ф3, 1Е365ПФ3 and others.

Even greater productivity is ensured by the use of turning two-spindle semi-automatic machines of models 1А720, 1А730, and others.

In mass production, multi-spindle turning semiautomatic models are used 1К282, 1283, 1Б284, 1А286-6 and others.

Lathe processing of large cylindrical wheels with a diameter of more than 500 mm for heavy machinery is performed on turning and turning machines. The wheels of the 8th degree of precision and less accurate are processed on turning and turning machine tools definitively. The wheels of the 7th degree of precision and precision are processed on turning-turning machines with the assumption for final machining after assembly with a shaft. The diameter of the billets processed on turning and turning machines reaches 20 m. By its arrangement, turning and turning machines are divided into one-piece (models 1508, 1510, 1512, etc.) and two-resistant (models 1520, 1525, 1540, etc.). Widely used turning and turning machine tools with CNC models 1512F3, 1516F3, 1525F3, and others. When finishing on turning and turning machines, an accuracy of 7-8th grade and a roughness of the surface of 3.2 ... 6.3 μm is achieved.

Treatment of the landing (central) hole. This hole is a technological base for the processing of a toothed wheel. For the transmission of a torque, the seat has a slot or slotted surface. The precision of the hole and the perpendicularity of its axis to the end of the hub in unglazed wheels is provided by finishing turning, turning, grinding or dragging.

The hole is draped out after drilling or winding round drafts. The accuracy of the hole after dragging corresponds to 7 to 9 qualifications. Roughness is 0.32 ... 2.5 microns. Productivity at dragging is much higher than when grinding.

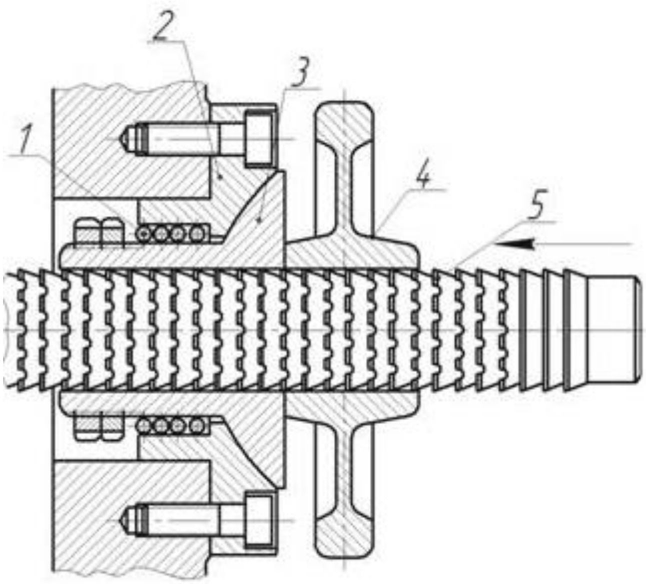


Figure 45 - Drawing of a hole with a circular drawer with the installation of a toothed wheel on a spherical support

Application of a spherical support provides perpendicular to the axis of the hole of the end of the wheel hub.

In the wheels, which are subjected to hardening, the hole is sanded on the internal grinding machine (fig. 46), and the end of the hub - on a flat-grinder.

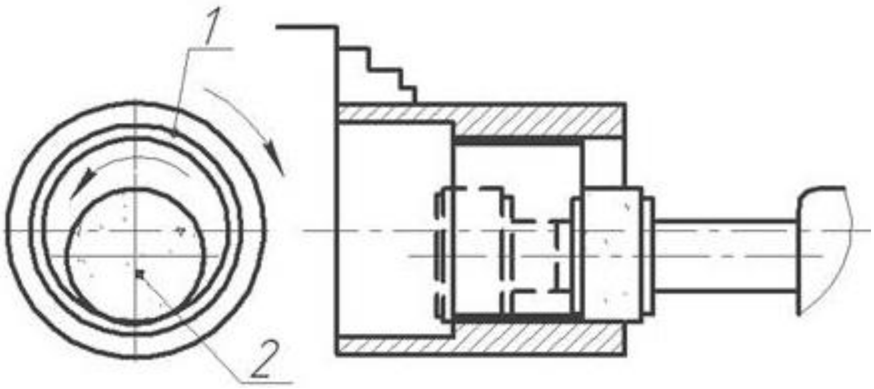


Figure 46 - Diagram of treatment of the opening on the internal grinding machine.

Shaft grooves and slots in the holes of gear wheels cut to hardening. In single and small-scale production, the slotted grooves are machined on lathe machines. In large-scale and mass production, the slotted grooves receive drafts. Shaft holes in gears are handled by pulling. If the gear is subjected to hardening after stretching, the centering of the splice connection is carried out mainly on the inner diameter of the shaft. In this case, after the hardening, the hole is sanded on a grinding machine, and the slots of the slot are polished on the shaft. If, however, when quenching the toothed wheel, the centering of the splice joint on the outer diameter of the shaft is to be made, the slits in the hole are subjected to honing over the cavities. For this purpose, a special model machine was created 3A856Ф1. The width of the hone bar is less than the width of the hollow slot. This allows him to perform oscillatory movements in a circular direction while moving along the axis of the opening. The shaft thus is sanded on the outer diameter.

Cutting teeth.Cutting of teeth is done by copying and rolling methods. Copy method.

The method of copying is used in single production, as well as for cutting large-wheel drive wheels. It has a low performance and accuracy of the 9th - 11th grade. The cutting of cylindrical gears with straight and oblique teeth is made by modular disk or finger-milling.

The milling profile corresponds to the cavity profile of the tooth. Mills are made with a set of 8 or 15 pieces for each module. Such quantity of milling cutters in a set is necessary because for different number of teeth of one module sizes of hollows between teeth are different. Each cutter is designed for a certain number of teeth intervals. Typically, a set of 8 mills is used, the processing of which allows the receipt of gears of the 9th degree of accuracy. For the manufacture of more precise wheels, a set of 15 or 26 milling cutters is used.

Cutting of teeth is carried out on universal milling machines with the help of a dividing head. The dividing head is installed on the table of the milling machine. With its help it is possible to accurately rotate the gear wheel to an angle corresponding to the step of the teeth.

Routing method. The method of rotation has been widely used because it provides high precision and performance. When threading simulates the process of toothed engagement. The teeth are cut by worm cutters, hammer and rails (Fig. 47).

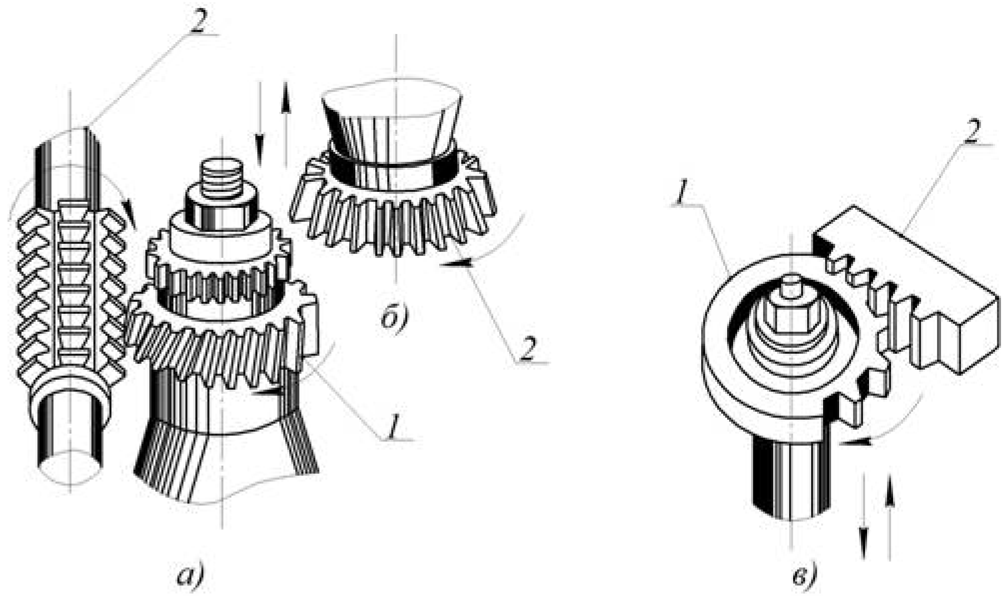


Figure 47 - Scheme of threading cylindrical gears by turning: a - worm mill, b - disk drive rod, in - comb; 1 - gear wheel; 2 – tool

Cutting teeth with worm cutters. Worm cutters cut straight and spit teeth on gear mills semi-automatic models 5303ПТ, 5304В, 53А20 and others The largest diameter of the blanks processed on these machines varies in the range of 20 - 3200 mm, the module is from 1 to 35 mm. When cutting edges, the milling wheels are set so that the angles of lifting the screw lines of teeth cutters and wheels coincide. Milling of the teeth is carried out with an axial or radial feed (Fig. 6.10).

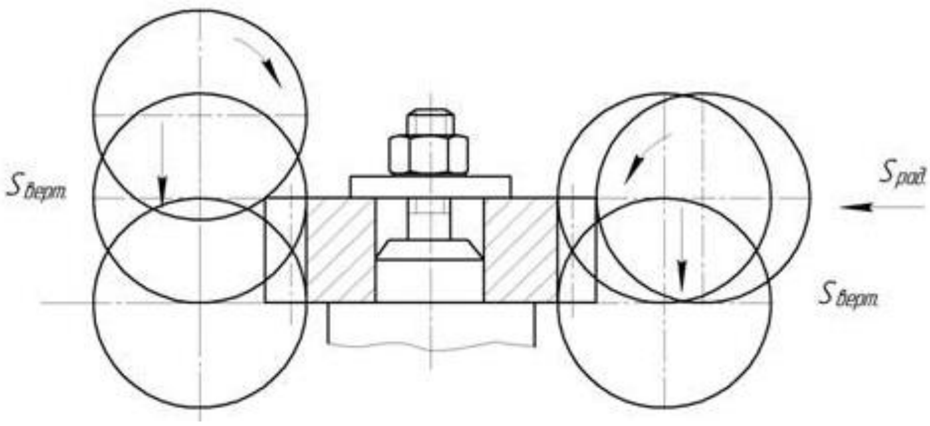


Figure 48 - Flints for grinding; a - with an axial feed, b - with radial and axial feeds

In the first case, the cutter is set immediately at the full height of the teeth and it has one flow of motion along the axis of the wheel. In the second case, the mill works initially with a radial feed, and then with an axial feed. Cutting of teeth with module up to 5 mm is carried out in one working step. Teeth with a large module are cut in two or three transitions with intermediate assumptions. Precision milling corresponds to 7 - 8th degree of accuracy of gear wheels with roughness of the surface to 0.63 microns.

The disadvantage of gumming is the uneven wear of the cutter teeth, because almost the entire discharge is removed by the first two or three teeth. For more even wear of teeth by kinematics of the machine, the milling machine is given additional displacement along its axis or reinstals the milling in the axial direction after cutting a certain number of gear wheels.

Cutting teeth with rails. The rails or comb are cut straight and spit teeth on the teeth-cutting machines. When cutting edges, the rake returns to the angle of inclination of the teeth. The technology of manufacturing and re-treading worn rails is simpler than cutters and chippers. However, the productivity of cutting by rails is lower than the milling cutters and chips. Therefore, this instrument has not been widely used in teeth grinding.

Toothpick. Rooting of teeth is carried out in a cold or hot state of a metal. When hot rolling, the workpiece is heated to a temperature of 1000 - 1200 degrees. The tool is a roller - a gear wheel with a tooth modulus of a machined wheel.

When tinting, the workpiece 1 and rotary knife 2 are rotated. The cutter has an axial or radial feed. Teeth on the preform are formed by pushing the teeth into the metal.

TASK

1. The purpose of cylindrical gears?
2. By design, cylindrical gears are divided into?
3. Requirements for the accuracy of gear wheels?
4. Thermal treatment of gear wheels?
5. Methods of obtaining billets for gear wheels?

LITERATURE

1. Бондаренко С.Г. Основи технології машинобудування. / С.Г. Бондаренко – Чернігів: ЧДТУ, 2005. – 567 с.
2. Бондаренко С.Г. Основи технології машинобудування : навч. посібник для студ. вищих техн. навч. закладів / С.Г. Бондаренко. – Львів : Магнолія 2009. – 567 с.
3. Бондаренко С.Г. Технології механоскладального виробництва: Монографія/ С.Г.Бондаренко. – Ніжин: ТОВ "Видавництво "Аспект-Поліграф", 2008. – 358 с.
4. Захаркін О.У. Технологічні основи машинобудування (основні способи обробки поверхонь та сучасні Т-системи для їх реалізації): навчальний посібник./ О.У. Захаркін.– Суми: Вид-во СумДУ, 2009. – 137 с.
5. Основы теории резания материалов: учебник [для высш. учебн. заведений] / Мазур Н.П., Внуков Ю.Н., Грабченко А.И. и др. ; под общ. ред. Н.П. Мазура и А.И. Грабченко. – 2-е изд., перераб. и дополн. – Харьков : НТУ «ХПИ», 2013. – 534 с.
6. Руденко П.О. Проектування технологічних процесів у машинобудуванні: Навчальний посібник./П.О.Руденко. – Київ: Вища школа, 1993. – 414 с.
7. Технология конструкционных материалов : учебник для механ. специальностей вузов / [Г. А. Прейс, Н. А. Сологуб, И. А. Рожнецкий и др.] ; под ред. Г. А. Прейса. — Киев : Выща школа, 1991. — 390с.
8. Технологія конструкційних матеріалів : підручник для студ. мех. спец. вищ. навч. закл. /[М. А. Сологуб, І. О. Рожнецький, О. І. Некоз, та ін.] під ред. М. А. Сологуба., 2-е вид., перероб. і доп. — Київ : Вища школа, 2002. — 374 с.
9. Черпаков Б.И. Металлорежущие станки: Учебник для нач. проф. образования / Б. И. Черпаков, Т. А.Альперович. — М.: Издательский центр «Академия», 2003. — 368 с.
10. Черпаков Б.И. Технологическое оборудование машиностроительного производства: учебник /Б.И.Черпаков, Л.И.Вереина. — М.:Академия, 2006.- 416 с.

11. Altintas Y. Manufacturing Automation: Metal Cutting Mechanics, Machine Tool Vibrations, and CNC Design/Y.Altintas. — Cambridge University Press, 2012. — 380p.
12. Vasylkovska K.V., Leshchenko S.M., Vasylkovskyi O.M., Petrenko D.I. (2016) Improvement of equipment for basic tillage and sowing as initial stage of harvest forecasting. INMATEH - Agricultural Engineering, 50(3). 13-20.
13. Beddoes J. Principles of metal manufacturing processes /Beddoes, Jonathan. — Burlington, MA: Elsevier Butterworth-Heinemann, 2003. — 326 p.
14. Creese, R. Introduction to manufacturing processes and materials /Creese, Robert C. — New York : Marcel Dekker, 1999. — 395 p.
15. Dan B. Marghitu Mechanical Engineer's Handbook/Dan B. Marghitu. — Academic Press, 2001. – 880p.
16. Klocke F. Manufacturing Processes, Cutting/ Fritz Klocke. — New York : Springer, 2011. — 504 p.
17. Stephenson D.A. Metal cutting theory and practice / Stephenson, David A. — New York: Marcel Dekker, 1997. — 898 p.
18. Zhang, L.Materials Processing Fundamentals/ [Zhang, L., Allanore, A., Wang, C., Yurko, J. A. and Crapps, J. (eds)].- John Wiley & Sons, Inc., Hoboken, NJ, USA, 2013. – 317p.