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

Synopsis of lectures on the subject

«Special technologies in mechanical engineering»

for students of all forms of study

Direction of preparation 131 " Applied mechanics"

Ternopil

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Ministry of Education and Science of Ukraine
Ternopil National Technical University
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Mechanical Engineering
department

Synopsis of lectures on the subject «Special technologies in mechanical engineering»
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Direction of preparation 131 " Applied mechanics"

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V.R. Pankiv. V.M. Baranovsky Synopsis of lectureson 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".

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INTRODUCTION

METHODS OF PROCESSING STRUCTURAL MATERIALS

1. Foundry production
2. Processing of metals by cutting
3. Processing of metals by pressure
4. Welding
5. New types of material processing (electrophysical, electrochemical)
6. Ultrasonic processing method

1 Foundry production

With the help of foundry production, castings and ingots are obtained - the primary product of the processing link of metal alloys. Its essence consists in the formation of shaped castings or ingots in the process of melting the so-called charge (pure metals, scrap metal, etc.) with the addition of refractories or melting in special furnaces - crucibles (for refractory metals).

All the metal that is placed in the furnace for melting is called charge. Before melting, charge calculation is carried out in order to determine the amount of charge materials, which is necessary to obtain an alloy of a given composition, taking into account losses during melting. In simple cases, the charge calculation is reduced to solving one or more equations. With a complex composition of the alloy, a large number of charge materials and the need to find their optimal set from the condition of the lowest cost, calculations are carried out using computer technology.

In the process of melting, the metal oxides that are formed are fused with silica, and a natural slag is formed, which keeps the metal in a bound form. In addition, the slag contains droplets of free metal that were mechanically captured during mixing. Thus, part of the metal is lost together with the slag. Another part of the losses is related to the evaporation of the metal and the interaction of the melt with the refractory lining. That is why these losses are called "fallback losses".

First of all, the charge with the largest share, as well as more refractory charge materials, is placed in the furnace. Volatile and small additives, as well as those that are strongly oxidized, should preferably be introduced with the help of ligatures. If necessary, a special slag or flux should be immediately added to the first portion of the charge.

For reliable dissolution of all additives, it is necessary to thoroughly mix the melt. If necessary, at the end of melting, the melt is refined, as well as its deoxidation. The final operation is the modification of the melt by the introduction of an additive or temperature-time treatment.

Often, a preliminary remelting of the charge, which is wet, contaminated with oil, is carried out, and the already obtained melt is poured into the ladles.

2 Processing of metals by cutting

Cutting processing includes two sets of ways of its implementation: blade and abrasive processing.

Blade processing involves processing the surfaces of the workpiece with single- and multi-blade tools - cutters, drills, milling cutters, reamers, broaches, etc.

Abrasive processing is the treatment of surfaces with abrasive tools made of natural or artificial abrasive materials, such as abrasive wheels, segments, bars, tapes and free abrasives in the form of powders, pastes, etc.

All methods of cutting processing are divided, in turn, according to the accuracy and roughness of the processed surface into:

- drafts;
- semi-pure;
- cleaning;
- decorative

3 Pressure treatment of metals

This type of processing uses the property of metal — plasticity (ability to change shape under the action of applied forces without destruction) in a cold or hot state. The most common mechanism of plastic deformation is sliding, the displacement of one part of the body relative to another under the action of tangential stresses. Processing of metals by pressure is one of the most common, most productive and cheapest methods of manufacturing blanks (parts) of various weights and sizes from metals and alloys.

Not all metals are equally ductile and can be treated by pressure to varying degrees. Metals such as copper, aluminum, lead, and titanium have good plasticity, and, therefore, are easily processed by pressure. Steel is plastic to a lesser extent, and therefore, to increase its plasticity and facilitate pressure treatment, heating is used.

Cold deformation occurs at temperatures lower than the recrystallization temperature, so it is accompanied by the elongation of grains, an increase in the saturation of defects, which increases the strength, elasticity and hardness of the metal (slander phenomenon). Cold deformation improves the quality of the surface and the strength of the metal. Slandering metal is not always useful, because hard and strong metal is difficult to cut. To facilitate the further processing of the metal, the defamation is removed by annealing. As a result of annealing, the strength and hardness of the surface layer of the metal decreases, which is important for further processing of the metal.

Hot processing of metals by pressure has a number of positive qualities: the constituent parts of the metal are distributed more evenly than before processing; grain sizes decrease, which leads to improved mechanical properties; the metal becomes denser. Pressure-treated steel has a fibrous structure. The mechanical properties of such steel along the fibers are better than the properties of steel across the fibers. This is explained by the fact that during pressure treatment the fibers are redistributed according to the shape of the part.

To obtain parts and blanks, metals are processed by pressure in the following ways:

• rolling is a pressure treatment of metal, during which the workpiece is pressed by rotating rolls of a rolling mill;

• drawing is the process of drawing blanks through a gradually narrowing opening;

• pressing (extrusion) — extrusion of metal from a closed volume through a calibration hole;

• forging is the processing of metal by the pressure of local application of deforming shock loads with the help of a universal support tool or strikers with free movement of metal in all directions [1];

Stamping is a method of obtaining blanks using stamps

4 Welding

Today, welding is the most common method of connecting parts in the manufacture of metal structures. Welding in combination with casting and stamping is widely used. To ensure the weldability of two parts of the material, it is necessary to bring them close enough to create an opportunity for the formation of interatomic bonds. This is possible in the case when the atoms of two parts of the material come closer to a distance of less than 4•10−10 m. Such conditions can be created in three ways:

• compression of parts without heat treatment,

• heating the material until it melts,

• heating to a plastic state and simultaneous compression of parts

1. Basic methods of welding
2. Manual arc welding
3. Welding with a fusible electrode
4. Welding with a non-fusible electrode
5. Gas flame welding
6. Electroslag welding
7. Plasma welding

8. Electron beam welding
9. Laser welding
10. Thermal welding
11. Induction welding
12. Ultrasonic welding http://uk.wikipedia.org/wiki/

5 New types of material processing

Physico-chemical methods of material processing (PHO) include methods that ensure the removal of material processed as a result of physicochemical processes. According to the mechanism of material destruction and removal, all physical and chemical processing processes are divided into three groups:

Electrophysical methods of processing (EPO) are based on the principle of the influence of heat flow on materials. That is, during processing, thermal effects are used, which accompany the flow of electric current, with the creation of high densities of thermal power in the processing zone. The main types of ETFs are:

Laser processing is based on the impact on the workpiece material of focused polychromatic (monochromatic) radiation, which causes heating, melting and (or) evaporation of the material being processed. For this type of ETO, special installations are used as a working tool, such as: gas or helium-neon lasers.

Laser processing is used for the following operations:

- cutting blanks;
- labeling;
- local alloying; soldering, etc.

Plasma processing – when it is used, physical processes occur, due to which changes in the composition, structure, or physical state of the material being processed occur as a result of exposure to low-temperature plasma, which in turn leads to a change in the shape or geometric dimensions of the workpiece. Special installations - plasmatrons (low-temperature plasma generators) are also used as a working tool for plasma ETO.

Plasma treatment is used for the following operations:

 hardening;

 carbidization;

 firing and modification of the surface of the material;

 plasma spraying and surfacing; glazing, etc.

Electrochemical processing methods (ECHO) are one of the modern methods of manufacturing parts from metals and alloys with specified shape, dimensions and surface quality. The following types of ECHO are distinguished:

Anodic ECHO occurs as a result of anodic dissolution of metal. It is advisable to use it for materials that are difficult to process by mechanical methods. This process takes place in the absence of contact between the workpiece and the tool, which makes it suitable for processing thin-walled parts that are easily deformed during mechanical processing; as well as parts made of fragile material that are prone to cracking and, as a result, deterioration of the operational qualities of the parts.

The advantages of anode ECHO can be considered:

 practical absence of tool wear;

 improvement of the surface quality of the part; increased accuracy of processing.

A significant drawback of the method is that the high electrical conductivity of electrolyte solutions leads to low localization of the process of metal removal and metal dissolution not only in the designated area, but also in the adjacent parts of the surface of the part.

Cathodic ECHO is characterized by the flow of electric current in an electrochemical system, while metal ions from the solution are released at the cathode (the cathode is a form). After the formation of a layer of metal of the required thickness on the form, the copy is separated from the form and the part is obtained.

Advantages of cathode echo:

• it has a high accuracy of reproduction of the geometric shape of the model and accurate copying of the surface relief;

• this type of ECHO makes it possible to reduce the labor intensity of manufacturing parts in comparison with traditional mechanical processing methods, and to reduce the number of workers.

A significant drawback can be considered that when the process is carried out in stationary galvanic baths, this process is very long, moreover, under such conditions, there is a great possibility of the occurrence of roughness. Combined processing methods

Each of the FHO methods has unique technological capabilities, but all of them are more energy-intensive and less productive compared to mechanical processing methods, besides, FHO installations are more expensive and complex, they require large production areas. Therefore, the use of FHO is advisable only in the following cases:

• for processing structural materials that have low machinability with blade and abrasive tools

(high-alloy steels, hard alloys, semiconductors, etc.);

• for processing details of a complex geometric shape from difficult-to-process materials (press molds, turbine blade parts, etc.);

• for processing miniature thin-walled non-rigid parts and parts of complex shape with grooves and holes.

The effectiveness of the application of FHO methods is more evident, the more complex the shape of the part being processed and the higher the physical and mechanical properties of the material, the greater the difficulties in its manufacture by machining methods.

FHO methods are used in the following operations:

1. procurement operations: FHO methods are used for cutting workpieces from hard-to-process heat-resistant and high-strength steels, titanium-based alloys (the advantage here is the practical absence of burrs on the parts);

2. forming operations: FHO methods are used in the production of parts by the methods of copying, stitching and electrochemical turning;

3. calibration (electrochemical and electrophysical): performed after mechanical processing of the screws, while the accuracy of the parts increases and the roughness decreases;

4. finishing operations: removal of burrs (FHO allows to remove them in hard-to-reach places) and polishing of surfaces;

5. polishing (electrochemical and electrophysical): improves the micro geometry of parts, reduces its roughness (on average by 2-3 grades), gives it a mirror shine.

6 Ultrasonic processing method

Ultrasonic abrasive treatment (UAO) has become widely used in industry. Its essence consists in changing the shape, size, roughness and properties of the surfaces of the workpieces and parts being processed, due to the removal of allowance material by fragile chipping of micro volumes under the pulsed force of an abrasive tool with an ultrasonic frequency, that is, the energy of ultrasonic vibrations is used during processing.

UAO is effective in processing blanks from structural materials that have low machinability by cutting, electrophysical and electrochemical processing methods (blanks from brittle, hard and chemically unstable materials, such as: glass, diamond, quartz, semiconductors, etc.).

The peculiarity of UAO is that before processing, blanks made of hard or fragile materials are glued to a substrate made of window glass, which prevents the appearance of wobbles on them.

UAO is used in the following technological operations:

1. Ultrasonic cutting is used to form blanks along the outer contour (for example, in the manufacture of watches and electronic equipment).

2. Ultrasonic flashing is the most common operation for obtaining through holes of various shapes with straight and curved axes, grooves and slits.

3. Ultrasonic grinding is mainly used for clean processing of flat external surfaces instead of grinding with a diamond tool, and defects such as cracks are

eliminated, surface roughness is reduced and productivity is increased (about two times), and high precision of the processed surface is achieved.

4. Ultrasonic deburring is based on the abrasive destruction of burrs. With this UAO method, processing is carried out in the working fluid, where the workpieces are treated with ultrasound. This type of processing of burrs is successfully used for their elimination on metal parts obtained by punching by punching methods, on cast parts made of plastics.

A significant disadvantage of UAO is the rapid wear of the abrasive tool, especially its end. To eliminate this shortcoming, the tool is made of plastic, but at the same time sufficiently hard annealed steel or brass (for a tool with a complex shape of the working part).

One of the methods of ultrasonic processing is ultrasonic welding of parts and blanks. The joining of parts with this method of processing occurs under the influence of ultrasonic vibrations: in welding equipment, high-frequency electrical vibrations are transformed into mechanical vibrations of the same frequency under the action of an alternating magnetic field.

The most rational and widespread is the use of ultrasonic welding in the following areas:

Processing of parts of small thicknesses. At the same time, ultrasonic welding has advantages due to the fact that, provided the parts have the same thickness, the diameter of the spot during ultrasonic welding can be larger than with other types of welding that are used for such parts.

1. Welding of parts of different thicknesses and dissimilar metals that cannot be welded or are difficult to weld by other methods. Substantial success has been achieved in ultrasonic welding of metals with non-metals, which leads to the widespread use of this type of welding in the electronic, radio engineering, and hardware industries.

2. Welding of parts from heat-treated materials. The absence of significant heating does not lead to a noticeable decrease in the strength of the metal of the adjacent zone.

3. Welding without preliminary cleaning of the surfaces of parts that are protected by a coating.

4. Ultrasonic welding is more economical in terms of electricity consumption.

However, ultrasonic welding has a number of disadvantages that significantly reduce the areas of its application, namely:

1. the thickness of the parts to be welded is limited to 1.5-2 mm;

2. there is instability of parameters of welding modes, and, as a result, instability of the strength of welded joints, which is quite difficult to eliminate and reliably control using nondestructive testing methods.

BASIC INFORMATION ABOUT METAL CUTTING AND METAL CUTTING MACHINES

1. The history of the development of metalworking in our country and abroad. Founders of the science of metal cutting
2. Basic requirements for machines
3. Trends in the technical development of modern machine tool construction

1 The history of the development of metalworking in our country and abroad. The founders of the science of metal cutting

Processing of metals by cutting was known in ancient times and was carried out first by hand, and then with the help of devices that greatly enhance the effect of the cutting tool. The first lathes and drilling machines with rotary motion from a water wheel appeared only in the 14th - 16th centuries. While working on the lathe, the worker held the cutter in his hands and moved it in the required direction, according to the shape of the surface being processed.

It was necessary to have a mechanism on the machine that would hold the cutter and thus replace the human hand. So at the beginning of the 18th century. (Namely, in 1712) the talented Russian mechanic A.K. Nartov (1680 - 1756) first designed and used in a lathe a caliper that moves along the processed part with the help of a gear wheel and rail. A. K. Nartov not only improved the lathe, but also created a number of machines of original design (screw-cutting, copying lathe, tooth-cutting, etc.).

The use of a caliper made it possible to use a machine tool, to create high-performance, multi-tool machines that allow the manufacture of various machine parts with a high degree of accuracy and speed. M. V. Sydorov, who created machine tools for drilling gun barrels ("water-operated machines") at the Tula Arms Factory in 1714, should be included among the outstanding machine builders.

In the middle of the century, the brilliant Russian scientist MV Lomonosov invented a ball-turning machine for processing metal mirrors, built face-turning and grinding machines. Cutting is one of the oldest methods of metal processing. Already in the 17th century in Russia, turning and drilling metal-cutting machines of a simple design were used. The beginning of the study of the cutting process was laid in the middle of the 19th century, when the need for the productivity of metal cutting by cutting increased in connection with the development of railway and water transport

The first stage of the development of the science of metal cutting

The founders of the science of cutting are Russian scientists. The first fundamental work on the cutting process belongs to the Russian scientist of the St. Petersburg Mining Institute, I. A. Time. He conducted systematic studies of chip formation and created a diagram of the chip formation process with its mathematical description, as well as derived formulas for cutting force and chip shrinkage.

In his experiments at the Luhansk plant, I. L. Timi investigated in detail all the most important issues of chip formation during the processing of plastic and brittle materials. they were the first to describe the mechanics of chip formation, and on the basis of experiments carried out in various conditions, a classification of types of chips, generally accepted at the present time, was compiled. Research conducted by I. A. Time was continued by P. A. Afanasyev and A. V. Gadolinii, whose work marked a new stage in the development of the science of metal cutting.

The theory of I. A. Time found further development in the works of A. P. Afanasyev, A. A. Briks, and especially K. L. Zvorykin, who produced a number of outstanding experiments on the determination of cutting forces by method and results. K. L. Zworykin conducted his experiments on a planing machine using an original hydraulic dynamometer designed by him, which was very advanced at that time. K. L. Zvorykin proposed a formula for calculating the specific cutting force, on the basis of which he established that when processing different structural materials, the width and thickness of the cut layer do not affect the main component of the cutting force in the same way.

The formula for determining the specific force proposed by K. A. Zvorykin was confirmed by all subsequent researchers and has been preserved in principle until now. K. A. Zvorykin discovered the system of forces acting on the contact surfaces of the tool and gave an analytical formula for determining the shear angle, qualitatively determining the influence of the factors of the cutting process on this most important indicator of chip formation. In 1893, the work of K. A. Zvorykin was published. In it, for the first time, the basic equation of the chip formation process is given, which establishes a connection between the shear angle and the conditions of contact of the chip with the front surface of the cutting tool. Shortly after this work, A. A. Brix's monograph was published, in which the elements of the mechanics of the metal cutting process were considered.

The second stage of the development of the science of metal cutting

At the end of the 19th century American researcher F. Taylor begins working in the field of metal cutting. F. Taylor's formulas for calculating cutting force and speed, intended for solving private practical problems, were only a statistical description of empirically accumulated information and did not affect the physical essence of the cutting process. All subsequent works of Russian scientists are aimed at researching physical phenomena during cutting in all their diversity.

In 1914, Ya. G. Usachev's outstanding research in the field of chip formation and thermal phenomena appeared. For the first time, Ya. G. Usachov used a metallographic method, more perfect than the visual method used by his predecessors, to study the process of chip formation.

The metallographic analysis of the roots of the chips allowed him to discover a number of new unknown facts and, in particular, to develop a theory of build-up, which was more reliable than Taylor's theory, which prevailed at that time. The works of Y. G. Usachev in the field of thermal phenomena are especially valuable. He used the calorimetric method to determine the amount of heat passing with the chip, and the method of connected thermocouples to determine the cutting temperature.

Studying the cutting temperature, Y. G. Usachev established the intensity of the influence of cutting depth, feed, and cutting speed on it, which was later confirmed analytically. Thanks to the efforts of I. A. Time, K. A. Zvorykin, Y. G. Usachov, and others, a domestic school of metal cutting was created, which studied the fundamental issues of the cutting process and far outstripped foreign research. In the period from 1900 to 1917, industry began to develop more strongly in Russia. Machine cutting speeds have increased almost 10 times over the past 20 years. For the construction of various factories, it was necessary to build machines, the parts of which were made by cutting.

For more economical manufacturing processes, it was necessary to study the cutting process in more detail. Among the studies of the beginning of the 20th century, the works of the master of the St. Petersburg Polytechnic Institute Ya.G.Usachev deserve special attention. He was the first to apply the metallographic method of studying the process of chip formation and measuring the cutting temperature with a thermocouple, and was the first to apply a turning dynamometer. He established the phenomenon of slander when cutting metals and gave a scientific rationale for the growth phenomenon.

The main results of his research were published in 1915 in the work "Phenomena that occur when cutting metals." After the revolution and civil war, the process of industrialization began in Russia (1920-1930).

The impetus for studying the science of cutting was the beginning of the rapid development of mechanical engineering, as the basis of the industrialization of the country. Machine-tool and tool factories were built, design bureaus were created. The beginning of the works of the Soviet period was laid by A.K. Chelyustkin, who was engaged in the research of issues in the field of cutting forces and in 1925 published the work "The influence of chip sizes on the forces of cutting metals."

This work was the result of a critical analysis of the metal cutting literature and a large number of experiments. His contribution is that he empirically verified and systematized data previously obtained by other scientists. In 1935, the Stakhanov movement was launched, which rejected the old standards that inhibit the development of technology. A commission on metal cutting was created under the chairmanship of E.P. Nadeinskaya, consisting of A.I. Kashirin, I.M. Besprozvanny, A.V. Krivouhov, S.D. Tishin and others, which carried out extensive research work on establishing the most important durable and power dependencies. The well-known work of E.P. Nadeinskaya "Investigation of cutting tool wear using radioactive isotopes".

The third stage of the development of the science of metal cutting

In 1937 - 1940, the possibility of processing ferrous metals with carbide tools of a special shape with a cutting speed of up to 250 - 300 rpm was proven. Since 1940, a number of leading factories (Bilshovyk, Kirovsky, Kolomensky, etc.) began to use cutters and cutters with hard alloy plates, which work at high cutting speeds.

During the Great Patriotic War, scientists devoted all their efforts to solving a number of practical tasks that increase labor productivity and the quality of defense industry products. The post-war period in the development of the science of metal cutting is characterized by a broad front of theoretical research into various aspects of the cutting process. At the same time, both the nature and methods of research are changing.

If in the pre-war period experimental methods prevailed, then in the future they are organically combined with analytical methods. Methods and means of experiments have changed qualitatively. To study various aspects of the cutting process, high-speed cinematography, polarization optical method, radioactive isotope method, X-ray and electronoscopy, scanning, etc. are widely used. Special equipment has been developed that allows for physical studies of the cutting process.

A large amount of experimental material accumulated as a result of the conducted research made it possible to begin the development of a general theory of the cutting process. G. I. Granovsky, V. A. Shishkov, S. S. Petrukhin and others developed cutting kinematics - a branch of the science of metal cutting that studies the principle kinematic schemes of cutting and the actual (working) geometric parameters of tools that determine the nature of chip formation and wear and stability of tools.

Known successes have been achieved by the technique of selecting lubricating and cooling fluids optimal for specific working conditions.

The theory of machinability of metals and alloys was also developed. Increasing the power and speed of metal cutting machines required the development of a theory of the stability of the cutting process. As a result of research by A. I. Kashirin,

N. A. Drozdov, L. P. Sokolovsky, L. K. Kuchma, V. A. Kudinov, and V. N. Poduraeva created a theory of oscillations during metal cutting, which marked the beginning of the calculation of metal cutting machines for vibration resistance

The fourth stage of the development of the science of metal cutting

The fourth stage of the development of the science of metal cutting begins approximately in the 50s of the 20th century. As in the previous stages, the beginning of a new stage in the development of science was facilitated by the intensive development of new materials for cutting tools, which could have characteristics that are an order of magnitude higher than the existing tool materials. So diamond became a new material. Diamond as a tool material has been widely used in mechanical engineering in recent years.

Currently, a large number of various tools using diamonds are produced: grinding wheels, tools for correcting grinding wheels made of electrocorundum and silicon carbide, pastes and powders for finishing and lapping operations. Large diamond crystals are used for the manufacture of diamond cutters, cutters, drills and other cutting tools; diamond grinding wheels are widely used for productive and high-quality sharpening of carbide tools, as well as products made of minerals and semiconductor materials.

Cutters equipped with a diamond are used for processing hard, heat-treated metals, minerals, billets from aluminum alloys with increased requirements for the quality of the processed surface. A new approach to learning the patterns of the cutting process was described in the work "Theory of Cutting.

Introductory chapters » in 1975. E. Kaluzhin

He notes that chip formation, wear of the cutting tool and the creation of a surface layer on the workpiece occur simultaneously and are closely interconnected. This collectively constitutes a single whole, characterized by the interdependence of its parts and is called the cutting system, which is a subsystem of the closed dynamic system of the machine tool. Along with the development of machine tools and tool materials, work is also being carried out to improve the sharpening of cutting tools. So, at ESHMS, under the leadership of E.Ya.Gradzinskogo and L.S.Zubatova, a diamond erosion method of grinding was developed, in which the microcutting process is combined with electroerosion grinding of circles, which is carried out directly in the workshop or outside it.

This was published in the article "Diamond erosion sharpening of trade cutters" in the magazine "Machines and tools" (1993)

2 Basic requirements for machines

The main requirements for a modern metal cutting machine can be formulated as follows.

1) the maximum possible productivity while ensuring the necessary and sufficient accuracy of the shape and dimensions of the product processed on the machine, the necessary and sufficient quality (cleanliness) of the surface;

2) simplicity and ease of maintenance;

3) it is possible to have small metal volume and dimensions, therefore, it is possible to have high productivity per unit of weight of the machine and unit of area occupied by it; 4) fairly low initial cost and low operating costs.

5) the manufacturability of the design, i.e. the ease of manufacturing all individual parts of the machine and the ease of assembly.

It is not difficult to understand that the fulfillment of all these most important requirements is often a difficult task, for the solution of which in modern machine-tool construction various tools are widely used, not only mechanics, as was the case in the relatively recent past, but also electrical engineering, hydraulics, pneumatics

3. Trends in the technical development of modern machine tool construction

The listed requirements determine the following trends in the technical development of modern machine tool construction:

1. Increasing cutting and feeding speeds in order to reduce machine time. In connection with this desire, searches for new cutting materials - hard alloys, mineral ceramics - and new constructions of abrasive tools are carried out.

The same goal is pursued by the increasingly widespread use of stepless drives (mechanical, hydraulic and electric) in many new models of machines.

2. Reduction of the auxiliary time spent on fixing the headers and removing the processed product, on switching speeds and feeds, on measuring the processed workpiece. This is achieved by the use of fast-acting clamping devices, improved control systems and especially the automation of machine work cycles. Recently, a number of models of machine tools have found the use of the so-called software control system, in which the program of the machine is dictated by the recording of the necessary cycle in the form of rows of holes in perforated tapes or cards, optical recording on film, magnetic recording on tape or drum, etc. .

3. Increasing the accuracy of machines for final processing of products. The processing error often does not exceed 0.01 mm \ on some machines, this error lies within 2-3 μm.

4. Increasing the rigidity and vibration resistance of machines in order to ensure the accuracy of the shape and dimensions of the product processed on the machine and high cleanliness of its surface.

5. The use of frames, racks, tables and other body parts made by welding from sheet steel, instead of heavier cast iron, casting. In this way, a large saving of metal is often achieved,

spent on the production of the machine.

6. Limiting the degree of versatility of machines in order to simplify the design and, therefore, reduce the initial cost of the machine, as well as operating costs (simplification of maintenance, cheaper repairs, etc.)

7. Application of aggregate structures in some groups of machines, i.e. structures obtained by combining standard nodes.

8. Unification of machine models created on the basis of one basic model by using as many of its nodes and details as possible in newly designed modifications of this model.

9. Creation of automatic lines for processing certain parts of machines based on complex automation of the technological process (including heat treatment, control,] / packaging, etc.).

10. Development of typical equipment for such automatic lines, on which the processing of parts should be carried out, which differ in size, but are similar in configuration (for example, bushings, gears, stepped rollers, etc.).

All these trends find expression in the design of modern machines and in this connection are discussed in more detail in the relevant sections of the book

The authors did not set themselves a goal - in all cases to cite in the book only the newest models of machines: at the modern rate of construction development

metal-cutting machines, such a goal is practically unattainable and, even more importantly, methodically not justified for a training manual. The principles of the device of many machines, the choice of design solutions are easier to understand and learn on the examples of simpler machines, which, however, contain all the nodes necessary for the machine to fulfill its technological purpose, but are structurally more visible than the same nodes in the latest models

METHODS OF RESTORATION OF PARTS

1. Restoration of parts by installing additional repair parts
2. Restoration by changing part of the detail
3. Restoration of parts by metalworking and mechanical processing
4. The method of restoring fits in conjugations by restoring worn parts to the size of new ones
5. Restoration of machine parts by mechanized welding and surfacing

1 Restoration of parts by installing additional repair parts

This is a type of repair size method. The essence of this method is that the worn surfaces of the parts are corrected by mechanical processing and newly manufactured additional repair parts are installed, which compensate for the worn and removed metal (gaskets, bushings, washers, etc.). If the part is a shaft, then a bushing is put on it for assembly. If there is a hole, then a sleeve is installed on it with a press.

For a strong and reliable connection of an additional repair part with the main one, it is necessary to correctly choose the fit and means of fastening (glue, welding, locking screws, pins, etc.). After installation, the additional repair part is machined to the nominal size of the coupling.

Thus, it is possible to restore heavily worn necks of shafts and holes of parts to the nominal size, without changing the structure and heat treatment of the main part, to obtain high quality of restored parts.

The disadvantages of such recovery include:

- reduction of stiffness and strength of the structure when an auxiliary part is introduced into the dimensional chain;
- deterioration of the working conditions of the connection (thermal stresses);
- reducing the rigidity of tolerances on newly installed chains when new parts are introduced into the dimensional chain.

This method is used when renewing the holes for the bearings in body parts (cases, gearboxes, gearboxes, various seating surfaces - renewing with sleeves)

2 Restoration by changing part of the detail

In fact, the method is similar to the considered method of installing additional repair parts. It consists of the following operations:

- removal of the defective part and preparation of the joint surface (heat-treated, complex parts - carriages, gear block, slotted, cardan shafts require local tempering before removal (mechanical processing) of the defective element);
- production of a replacement part (the material of this part is the same as the main part, it is made to the normal size without allowances for subsequent processing, except when the alignment or accuracy of the mutual location, which is fixed on this part of the part, heat treatment before installation on the main part is required);
- connection and fixing of the changed part (performed by fitting on a thread, pressing, welding, etc. After welding, normalization or annealing is used to relieve stresses);
- final mechanical processing and control (the part is machined to the nominal size and all parts are checked for alignment and mutual location of all elements).
- As a rule, expensive and complex parts are repaired in this way, for example, multi-crown gears, etc.

3 Restoration of parts by metalworking and mechanical processing

One of the types of metalworking and mechanical processing is the pinning of cracks and the installation of patches.

Pinning restores tightness in inappropriate body parts, but it does not provide an increase in strength. First, the ends of the crack are drilled, a thread is cut into them, and pins with a diameter of 4...6 mm are screwed in. Then, in a certain sequence, from the ends towards the middle, other pins are drilled and installed. At the same time, each pin overlaps the adjacent one by about 1/3 of the diameter, as shown in the figure.

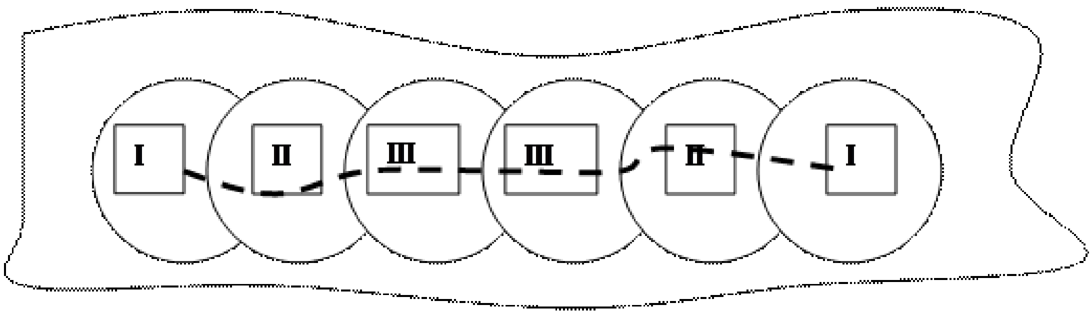


Figure 1 – Crack pinning scheme

Pins are made of copper or other soft metals (brass). After installing the pin head, they are brushed and cleaned, and sometimes they are soldered with soft solder.

Holes and cracks in body parts, frames, and feather parts are repaired by installing patches. Patches are made of sheet steel with a thickness of 1.5...2.0 mm. To repair the plumage, a material with a thickness equal to the thickness of the part is used. The borders of the cracks (the dimensions of the hole) are set, they are cleaned and the ends are drilled. The size of the patch should be such that it extends beyond the hole or crack by 15...20 mm.

Fix the patch with screws or rivets at a distance of 10...15 mm from each other, weld by contact or gas welding. Before installing the patch and the place of its installation, smear it with paint or paint, and install a gasket for tightness.

Locksmith and mechanical processing also includes such repair methods as lapping and grinding (valve seats of the cylinder block).

4 The method of restoration of landings in conjugations by restoration worn parts to the size of new ones

This method completely restores the performance of the part and does not complicate the organization of repair and supply of spare parts. The method is progressive and is performed in the following ways at modern repair enterprises:

- manual arc and gas welding (surfacing);
- mechanized means of surfacing: automatic arc surfacing (ADN) under a layer of flux, in an environment of protective gases, with an open arc;
- semi-automatic arc welding under the same conditions: vibrating arc welding (VDN); automatic wide-layer arc surfacing (ASS);
- electrochemical and chemical coating: chrome plating, iron plating, zinc plating, copper plating, nickel plating, anodizing;
- plastic deformation;
- synthetic materials (epoxy resins, glues, putties, pastes); - metallization by sputtering: plasma sputtering, gas powder deposition, detonation sputtering.

The choice of the method of renewal of landing is determined by the structural features of this connection and technical and economic feasibility

5 Restoration of machine parts by mechanized welding and surfacing

Welding is the process of obtaining inseparable joints by establishing interatomic bonds between the parts to be welded.

Surfacing is the process of applying a layer of metal to the surface of the product by welding.

Classification of types of metal welding used in repair production :

1) electric arc welding and its varieties;
2) electroslag;
3) electron beam;
4) termite; 5) gas.

According to physical characteristics, these types of welding are thermal. Other types:

Thermomechanical:

- contact;
- diffusive;
- press (gas, arc, slag); Mechanical:
- cold (without preliminary heating):
- blacksmith shop (with preliminary heating);
- explosion welding;
- ultrasonic;
- friction;
- magnetic pulse; - induction.

According to the method of arc protection, welding is classified according to such features as welding: in air, in vacuum, in gas, under a layer of flux, in foam, combined protection, self-shielding wire.

According to the continuity of the process: continuous, continuous.

According to the degree of mechanization of the process: semi-automatic, automatic.

The practical experience of SGM repair showed that a particularly important place in the process of repairing machine parts is occupied by welding and surfacing, which account for 80% of all parts in the nomenclature and 60% in terms of technological labor intensity. Repair of parts by welding and surfacing is economically beneficial. It allows you to reduce the cost of parts by 40% (compared to new ones) while maintaining their service life. At the same time, the proportion of deposited metal is no more than 10% of the total mass of the part. The weldability of metals is understood as the ability of a metal or a combination of metals to form a joint that meets the requirements of the design and operation of parts with the established welding technology.

Types of surfacing:

Electric arc surfacing - a type of welding - surfacing in which heating is carried out by an electric arc.

Electroslag surfacing - a type of welding - surfacing, in which heat is used to heat the metal, which is released when an electric current passes through the electrode and the molten flux (slag bath).

In plasma surfacing, heating is carried out by a compressed arc. Thermite surfacing - heating is carried out by burning a powdered thermite mixture.

Gas surfacing is a type of welding and surfacing, in which heating is carried out by the flame of gases that burn at the outlet of the gas welding torch.

Manual arc welding (MAR) is carried out with an artificial electrode. The supply of the electrode to the arc zone, the movement of the electrode across the seam and the movement of the arc along the seam are carried out manually.

Automatic arc welding (ADN) is an arc welding in which the supply of the electrode that melts into the arc zone, movement across the seam and movement of the arc along the seam are mechanized. In addition, excitation and maintenance of the arc is performed in automatic mode.

In semi-automatic arc welding (ADF), only the electrode supply is mechanized.

Modern devices for automatic arc welding are classified as follows:

I. According to the arc protection method:

- surfacing under flux;
- surfacing in the environment of protective gases;
- open arc welding with flux cored wire.

II. By type of electrodes:

1) by wire:

- cold-drawn steel;
- powder; 2) tape:
- cold-drawn steel;
- cast iron; - powder;
- metal-ceramic.

III. According to the method of movement of the electrode:

- at a constant speed without vibration and oscillations;
- with electrode oscillation;
- with electrode vibration - vibration - arc welding (VDN).

IV. By the number of arcs:

- single-arc surfacing;
- two and multi-arc surfacing. V. By the number of electrodes:
- single-electrode surfacing;
- two- and multi-electrode surfacing.

Questions to check

1. Restoration of parts by installing additional repair parts
2. Restoration by changing part of the detail
3. Restoration of parts by metalworking and mechanical processing
4. The method of restoring fits in conjugations by restoring worn parts to the size of new ones
5. Restoration of machine parts by mechanized welding and surfacing

MAIN PARTS AND ELEMENTS OF THE CUTTER, ITS GEOMETRIC PARAMETERS

1. Purpose and arrangement of incisors
2. Classification of incisors

1 Purpose and arrangement of incisors

A turning cutter is the simplest type of cutting tool, on the example of which the geometry of a more complex tool is studied. To fully use the cutting properties of the cutter, it is necessary to give its cutting part a rational shape. Let's consider the main elements of the cutting part of the cutter.

The cutter consists of the head II - the working part (Fig. 2), on which the cutting surfaces and edges are located, and the body - the holder, which serves to fix the cutter on the machine's caliper.

The following cutting surfaces of the cutter are distinguished: the front surface is the surface on which the chip descends; rear surfaces face the workpiece. Fig. 2 shows the rear main and auxiliary surfaces. The intersection of the front and back surfaces forms the cutting edges.

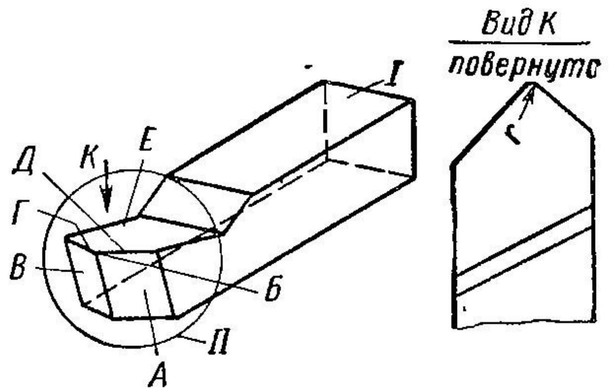


Figure 2 - Rear surfaces face the workpiece

To achieve the required size, shape and accuracy of the product, layers of material are removed from the workpiece (sequentially cut) with the help of a cutter. Rigidly fixed on the machine, the cutter and the workpiece come into contact with each other as a result of relative movement, the working element of the cutter is cut into the layer of material and its subsequent cutting in the form of chips.

The working element of the cutter is a sharp edge (wedge) that cuts into the layer of material and deforms it, after which the compressed element of the material is chipped and displaced by the front surface of the cutter (the surface of the chip exit). With further advancement of the cutter, the chipping process

is repeated and a chip is formed from individual elements

The turning cutting tool consists of the following main elements:

1. Working part (head);
2. Rod (holder) - serves to fix the cutter on the machine

The working part of the cutter is formed

- The front surface is the surface along which the chip descends during the cutting process.
- The main back surface is the surface facing the cutting surface of the workpiece.
- Auxiliary rear surface - a surface facing the machined surface of the workpiece.
- The main cutting edge is the line of intersection of the front and main back surfaces.
- Auxiliary cutting edge - the line of intersection of the front and auxiliary rear surfaces.
- The tip of the cutter is the point of intersection of the main and auxiliary cutting edges

2 Classification of incisors

1. According to the direction of submission, there are:

The right

The right one is called an incisor, in which, when the palm of the right hand is placed on top of it so that the fingers are directed to its top, the main cutting edge will be under the thumb. On lathes, these cutters work when feeding from right to left, that is, to the front headstock of the machine.

The left A left-handed cutter is called a cutter whose main cutting edge will be under the thumb when the left hand is placed on it in the above-mentioned manner.

2. According to the design, there are:

- Direct - cutters in which the axis of the cutter head is a continuation or parallel to the axis of the holder.

- Bent - cutters in which the axis of the cutter head is inclined to the right or left of the axis of the holder

- Curved - cutters in which the axis of the holder is curved when viewed from the side.

- Pulled - cutters in which the working part (head) is already a holder.

3. According to the cross-section of the rod, there are:

- rectangular.

- square.

- round

4. According to the manufacturing method, there are:

- targets are cutters in which the head and holder are made of the same material. - components - the cutting part of the cutter is made in the form of a plate, which is attached in a certain way to a holder made of structural carbon steel. Plates made of hard alloy and rapid are soldered or fastened mechanically.

5. By type of material there are:

- from tool steel. from carbon steel. The designation of such steel begins with the letter U, it is used at low cutting speeds. - from alloy steel. The heat resistance of alloy steels is higher than that of carbon steels, and therefore the permissible cutting speeds for cutters made of alloy steels are 1.2-1.5

times higher.

- from high-speed steel (high alloy)

. Designation of such steel

begins with the letter P (Rapid), cutters from it have increased productivity.

- from hard alloy.

Cutters equipped with hard alloy plates allow higher cutting speeds than cutters made of high-speed steel. metal-ceramic tungsten VK group alloys consist of tungsten carbide cemented with cobalt.

- titanium tungsten.

Alloys of the TK group consist of tungsten-titanium carbides cemented with cobalt.

- titanium tantalum tungsten.

Alloys of the TTK group consist of carbides of tungsten, titanium and tantalum, cemented with cobalt. mineraloceramic. Materials based on technical alumina (Al2O3) have high heat resistance, but at the same time, high fragility, which limits their wide application. kermetovy The basis of these materials is mineral ceramics, but to reduce fragility, metals and metal carbides are introduced into it. Elborov. Based on cubic boron nitride.

- diamond.

6. According to the nature of the installation in relation to the processed part, cutters can be of two types:

- radial.

They work with the installation perpendicular to the axis of the processed part. They are widely used in industry due to the simplicity of their fastening and a more convenient choice of geometric parameters of the cutting part - tangential.

When the tangential cutter is working, the force Pg is directed along the axis of the cutter, due to which the body of the cutter does not bend. It is used mainly on automatic and semi-automatic lathes, where the purity of the processing is the basis

7. According to the nature of processing, there are:

- scraps (drafts).
- cleaning

Finish cutters differ from rough cutters by an increased radius of rounding of the top, due to which the roughness of the processed surface decreases. cutters for fine turning.

8. By type of processing

According to the use on machines, cutters are divided into

- lathes
- planing rooms
- dovbalni

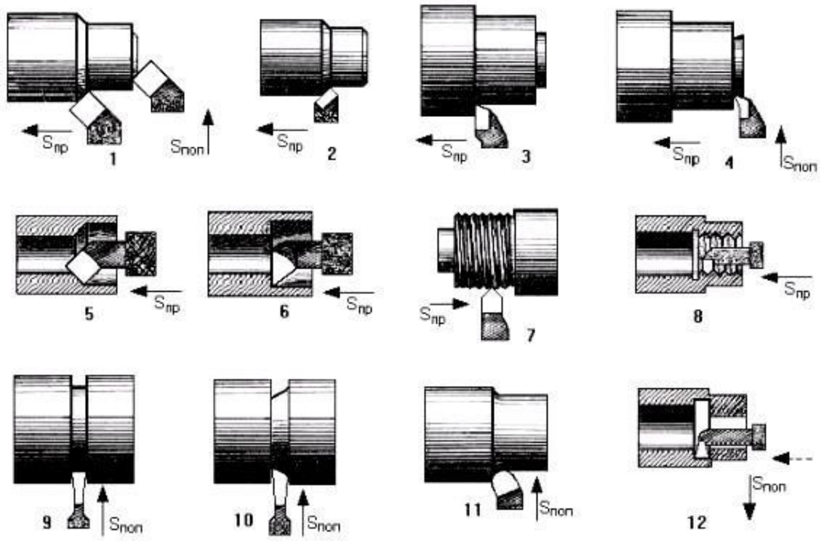


Figure 3- Types of turning cutters:

1 - passage bent;

2 - passing line;

3- a passer-by;

4- cutting;

5 - boring bent;

6 - boring undercut;

7, 8 - threaded;

9 - slotted (grooved);

10 - cut-off;

11 - chopsticks;

12 - rastochnoy zealous

A cutter that removes shavings during rectilinear mutual movement of the cutter and the material is called a planer (for horizontal cutting) or gouge (for vertical). The nature of the work of planing and gouging cutters is the same and differs from the work of turning cutters, where the cutting is continuous. Both when planing and when finishing, the cutter cuts only during the working stroke. At the same time, shocks occur at the beginning and end of each stroke, which adversely affect the work of these incisors.

Turning cutters

- through - for boring workpieces along the axis of its rotation.

- undercutting - for undercutting ledges at right angles to the main turning direction or for facing.

- cutting - for cutting workpieces at a right angle to the axis of rotation or for cutting narrow grooves under a retaining ring, etc.

- boring machines - for boring holes.

- chamfered - for removing chamfers.

- shaped - for individual turning works. When processing shaped parts, ordinary turning cutters do not ensure the accuracy of obtaining a profile and are not very productive. In large-scale and mass production, special shaped cutters are used as the main type of cutting tool for processing complex parts. They ensure the identity of the form (pattern), dimensional accuracy and high productivity. - slotted (grooved) - for the formation of grooves on the outer and inner cylindrical surfaces.

- threaded - for cutting threads.

GEOMETRY OF CUTTERS

1. Angles of the cutter in the cutting process
2. Dependence of angular parameters of the cutting process on conditions

1. Geometry of incisors

The following planes are set to determine the cutter angles:

The cutting plane is the plane tangential to the cutting surface and passing through the main cutting edge.

The main plane is a plane parallel to the feed directions (longitudinal and transverse).

The main cutting plane is a plane perpendicular to the projection of the main cutting edge on the main plane.

Auxiliary cutting plane - a plane perpendicular to the projection of the auxiliary cutting edge on the main plane

Principal angles are measured in the principal secant plane.

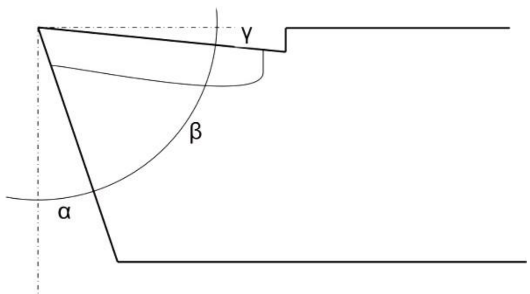


Figure 4 - The sum of the angles α + β + γ = 90 °

The main rear angle α is the angle between the main rear surface of the cutter and the cutting plane. It serves to reduce friction between the back surface of the cutter and the part. As the back angle increases, the roughness of the machined surface decreases, but with a large back coal, the cutter may break. Therefore, the softer the metal, the larger the angle should be. The sharpening angle β is the angle between the front and the main back surface of the incisor. Affects the strength of the cutter, which increases with increasing angle. The main front angle γ is the angle between the front surface of the cutter and the plane perpendicular to the cutting plane, drawn through the main cutting edge. It serves to reduce the deformation of the cut layer. With an increase in the front angle, it becomes easier to insert the cutter into the metal, the cutting force and power consumption decrease. Cutters with negative γ are used for scraping work with impact load. The advantage of such cutters in scraping works is that the blows are not perceived by the cutting edge, but by the entire front surface

Cutting angle δ = α + β

Angles in the plan are measured in the main plane

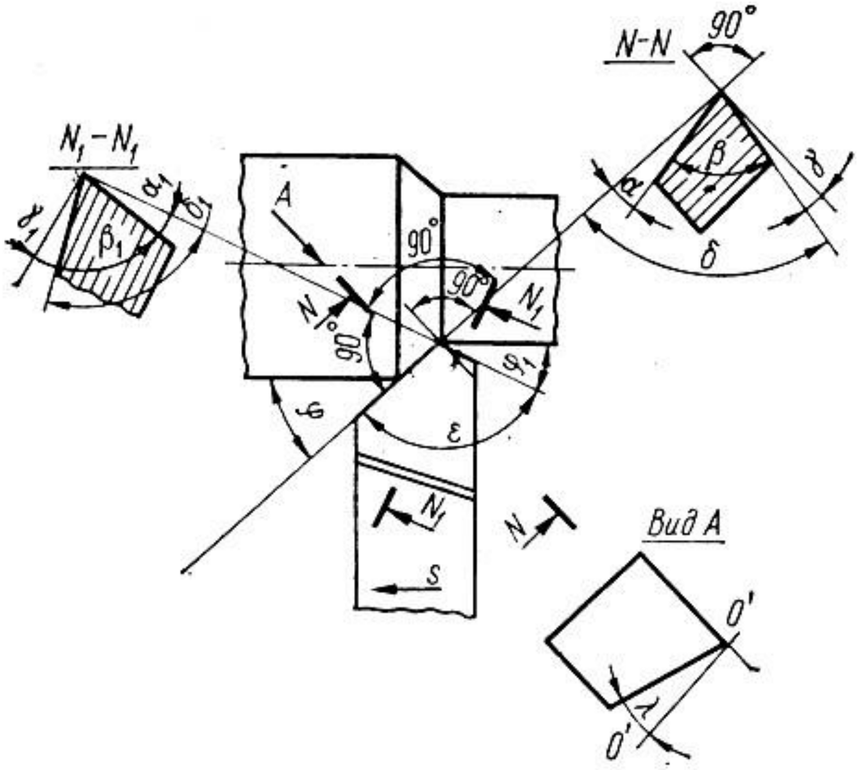


Figure 5 - The sum of the angles

φ + φ1 + ε = 180 °

The main angle in the plan φ is the angle between the projection of the main cutting edge of the cutter on the main plane and the direction of its feed. It affects the stability of the cutter and the cutting speed. The smaller φ, the higher its stability and the permissible cutting speed. However, at the same time, the radial cutting force increases, which can lead to unwanted vibrations Auxiliary angle in plan φ1 - the angle between the projection of the auxiliary cutting edge of the cutter on the main plane and the direction of its feed. Affects the cleanliness of the treated surface. As φ1 decreases, the surface cleanliness improves, but the friction force increases

The angle at the top in the plan ε is the angle between the projections of the main and auxiliary cutting edges of the cutter on the main plane. Affects the strength of the cutter, which increases with increasing angle.

The angle of inclination of the main cutting edge is measured in a plane passing through the main cutting edge perpendicular to the main plane

The angle of inclination of the main cutting edge λ is the angle between the main cutting edge and the plane drawn through the top of the cutter parallel to the main plane. Affects the direction of the chips

2. Dependence of angular parameters of the cutting process on conditions

All dimensions of the angular parameters of the cutter will be preserved during the cutting process only if the tip of the cutter is set at the height of rotation of the workpiece, the geometric axis of the cutter is strictly perpendicular to the axis of rotation of the workpiece, and the vector of feed speed is directed along the axis of rotation of the workpiece (perpendicular to the axis of the cutter).

Any deviations from these provisions (accidental or special) lead to changes in the values of one or more angular geometric parameters. Figure 5 shows the effect of turning the cutter around the vertical axis at a certain angle w. At the same time, the values of angles j and j1 change. All other angular parameters do not change.

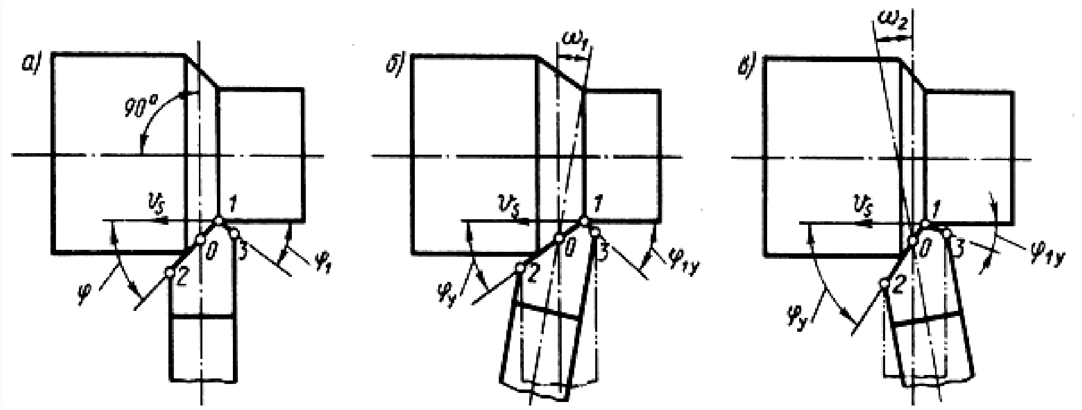


Figure 6 – Types of cutting

The effect of displacement of the top in the vertical direction is shown in Fig. 6. Setting the tip of the cutter above (Fig. 6) or below the axis of rotation automatically leads to a change in all angular parameters of the cutting process (*a,g,l,j,j1*). When installing the cutter above the center of the workpiece by a certain amount H, it leads to a change in the actual values of the front and back angles by a certain amount q, , then *af* = *a-q* and *gf=g+q.*

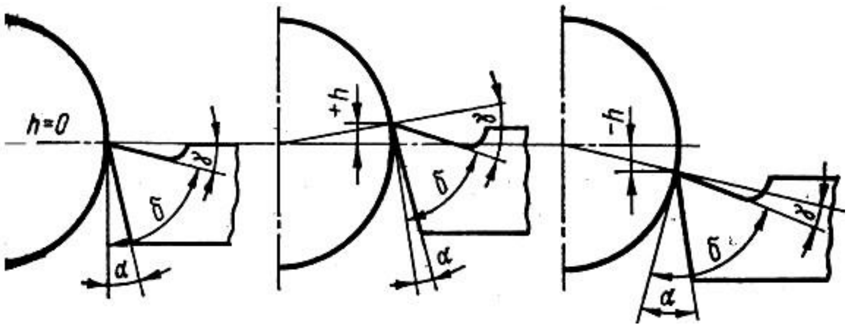


Figure 7 - The effect of displacement of the top in the vertical direction

When installing the cutter h below the center of the workpiece, the actual values of these angles will have the following values: *aф= a+q* and *gф=g-q*. The given dependencies are valid for angles measured in a plane passing through the top of the cutter perpendicular to the axis of the workpiece. In the cutting plane, the change of these angles is determined by more complex dependencies.

ELEMENTS OF CUTTING AND CUT LAYER

1. Classification of movements in metal cutting machines
2. Elements of cutting and the cut layer
3. Processing schemes
4. Cutting mode

1. Classification of movements in metal cutting machines

In order to carry out the process of cutting a layer of metal from a workpiece, it is necessary to provide a certain set of movements to the cutting tool and the workpiece, which are installed and fixed in the working bodies of the machine tools. The movements of the working bodies of the machine tools are divided into movements:

- cutting
- installation
- auxiliary
- interconnected

Cutting movements are movements that ensure the removal of a layer of metal from the workpiece or cause a change in the state of the processed surface of the workpiece. These include the main movement and the feed movement.

The main movement provides direct chip removal. It determines the rate of deformation during cutting. The feed movement ensures the cutting of the tool into the workpiece material, that is, the continuity of the cutting process. The main movement is most often rotary (lathe, drilling, milling, grinding machines), translational (drawing machines) or reverse-translational (boring and planing machines). It can be given to the workpiece (lathes, longitudinal planing machines), the tool (drilling, milling, grinding, cross-planing machines) or both the workpiece and the tool at the same time (for example, when drilling small holes or cutting threads on automatic lathes)

The feed motion is translational in most cases. It can be provided both to the tool (lathe, drilling machines) and to the workpiece (milling, honing, planing, flat grinding machines). In some cases, the feed movement can be provided simultaneously to both the tool and the workpiece. For example, during round grinding of shafts, the feed movements are the longitudinal movement of the grinding wheel (tool) and the rotation of the workpiece.

The last movement is called circular feed.

In machines with a rotary main movement, the feed movement is continuous, so the cutting process is also continuous. In machines with a reciprocating main movement, where the working movement alternates with the idle, the feed movement is carried out before the start of each work stroke and, thus, the cutting process is intermittent.

In metalworking, the speed of the main movement is denoted by v, the feed rate is movements that ensure such and such a position of the tool relative to the workpiece, during which a certain layer of material is cut from it, are called setting movements. The auxiliary movements of the working bodies of the machine tools do not have direct relation to the cutting process and are needed, mainly, to increase the productivity of the machines. These are movements such as transporting the workpiece, fixing it on the machine, rapid movement of working bodies, etc.

Interrelated movements are movements that provide a certain mutual connection between the workpiece and the tool in some types of work. For example, when turning or milling a thread, for each revolution of the workpiece, the tool must move along the workpiece by one step of the thread; when milling gear wheels with worm cutters, the running-in movement must be ensured, i.e., in one rotation of the cutter, the workpiece must turn by the number of teeth equal to the number of steps of the cutter.

2. Elements of cutting and the cut layer

The depth of cut is the distance between the processed and processed surfaces of the workpiece, which is measured perpendicular to the latter, in one working stroke of the tool relative to the processed surface

The cutting depth is measured in millimeters. When turning a cylindrical surface, the depth of cut (in mm) is determined as the half-difference of the diameters before and after processing

$$t = \frac{D_{заг} - d}{2}$$

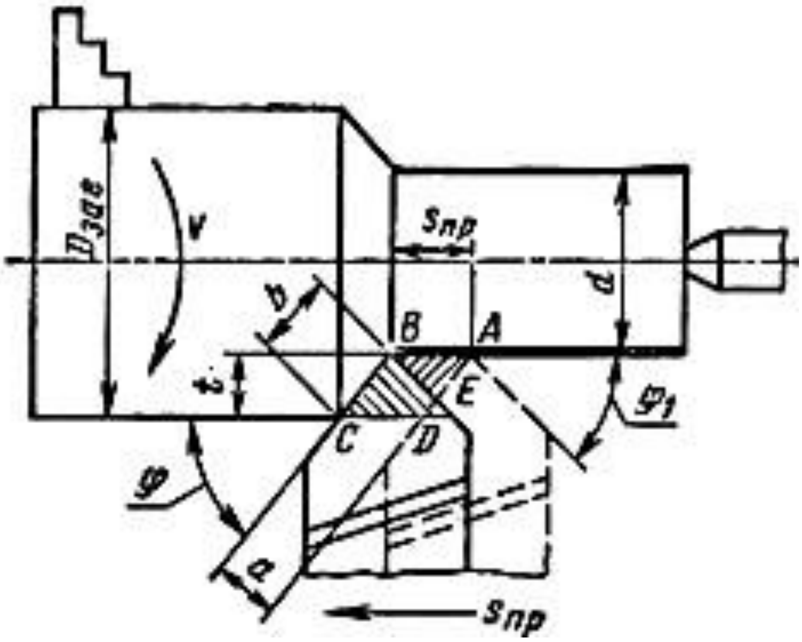


Figure 7 - Two consecutive positions of the cutter relative to the workpiece

where d is the diameter of the processed cylindrical surface, mm.

When considering the physical essence of the cutting process, the concepts of the width and thickness of the layer of the material being cut are used.

The width of the layer to be cut b is the distance between the machined and machined surfaces, measured along the cutting surface.

The thickness of the layer to be cut a is the distance, measured normal to the cutting surface, between two successive positions of the cutting surface during one revolution of the workpiece.

In fig. 7 two consecutive positions of the cutter relative to the workpiece during one complete revolution are shown. During this time, the cutter removes material from the workpiece, the cross-sectional area f_{ABCD} of which is called the nominal cross-sectional area of the layer being cut.

3. Processing schemes

For any cutting process, it is possible to draw up a processing scheme, which conditionally shows the processed workpiece, its installation and fixation on the machine, the position of the tool relative to the workpiece, as well as cutting movements. The tool is shown in the position that corresponds to the end of processing the surface of the workpiece.

The treated surface is distinguished by a different color or thickened lines. The processing diagrams show the nature of cutting movements and their technological purpose, using conventional designations: s poz - longitudinal feed s pop - transverse s circular - circular sv - vertical, etc.

In the cutting process, a machined surface 1, machined 2 and cutting surface 3 are distinguished

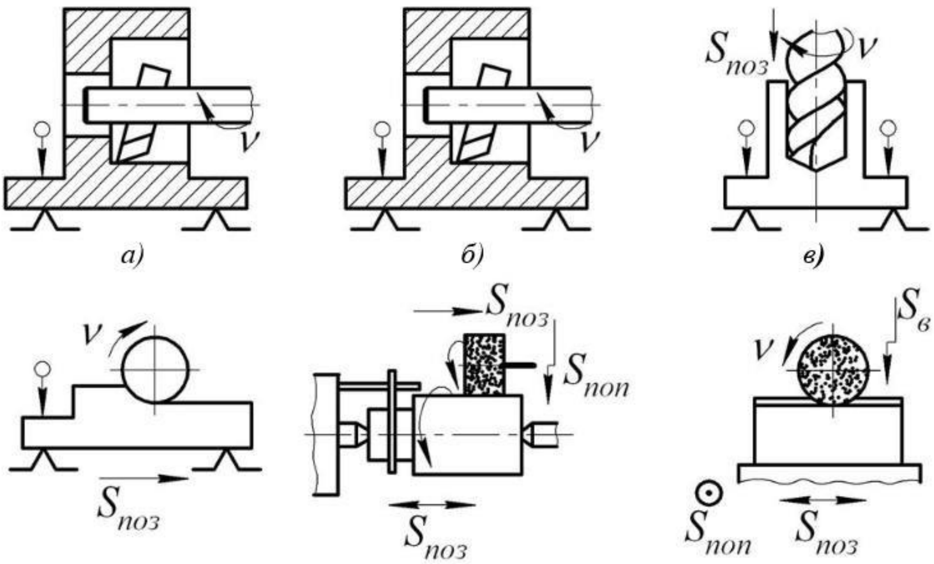


Figure 8 - Workpiece processing schemes: a– turning; b – boring; c – drilling; d – milling; d – grinding on a circular grinding machine; e – grinding on a flat grinding machine

4. Cutting mode

The main elements of the cutting mode are cutting speed, feed and cutting depth.

The cutting speed v is the distance traveled by the point of the cutting edge of the tool relative to the workpiece per unit of time. The cutting speed is measured in m/min or m/s. If the main movement is rotary, then the cutting speed, m/x v = πDn/1000, where

D is the diameter of the body that carries out the main movement, mm; n is the rotation frequency of this organ per minute.

If the main movement is reciprocating, and the speeds of the working and idle strokes are different, then the cutting speed, m/min:

$v = L \cdot m \cdot (k+1)/100$,

where L – stroke length of the tool or workpiece (for longitudinal planing), mm; m is the number of double moves of the tool or workpiece per minute; k is a coefficient that shows the ratio of the speeds of the working and idling strokes.

If these speeds are the same, then the last formula will have the form:

$$v = 2Lm/1000$$

Feed s is the path of the point of the cutting edge of the tool relative to the workpiece in the direction of movement of the feed for one revolution or for one stroke of the workpiece or tool. The feed, depending on the technological method of processing, has the dimensions: mm/rev. – for turning and drilling;

mm/sub. stroke – for gouging, planing and grinding; mm/tooth – for milling

The cutting depth t is the distance between the processed and machined surfaces of the workpiece, measured perpendicular to the latter, that is, the thickness of the material removed in one pass. The cutting depth has a dimension of mm

During turning $t = (D_{total} – d)/2$, where

D_{zag} – workpiece diameter, mm; d is the diameter of the processed part, mm. When drilling

$t = D_{св}/2$, where

$D_{св}$ – drill diameter, mm; when boring or drilling

$t = (D_1 – D_0)/2$, where

D_1 – diameter of the machined hole, mm;

D_0 – diameter of the initial hole, mm

TECHNOLOGY OF PROCESSING BODY PARTS ON AUTOMATED MACHINES

1. Multipurpose machines
2. Aggregate machines
3. CNC machines
4. Requirements for machinability of body parts and workpieces processed on automated machines
5. Features of the technological process of processing billets of body parts on automated machines

1. Multipurpose machines

High-performance metal-cutting machines of the multi-purpose type, which carry out the program of automatic change of machined billets and cutting tools, allow to automatically make from one installation practically complete processing of the body detail from 4-5 sides. The presence of multi-tool shops with a wide range of cutting tools allows you to automatically perform at one or more operating positions from one batch installation various technological transitions from the processing of flat and shaped surfaces, from machining of main and fixing holes, from threading and obtaining necessary slots and a loophole. In this case, you can perform such work as milling of flat surfaces and milling along the contour, coordinate drilling, boring, threading. The machine tool is controlled by a program written on a punch tape or coming from a computer. The program changes within 1.5 - 4 minutes.

Basing the workpieces on multi-purpose machines takes place on the table of the machine tool or in devices of a simple type without guiding bushings for the tool.

For processing of workpiece from different directions on multi-purpose machine tools use precise rotary tables, allowing the program to rotate the workpiece to the required angle. In order to increase the efficiency of the use of the machine in a number of cases, variable tables or satellites are used, which allows you to set the workpiece in the process of processing, thus combining the main and auxiliary transitions in time.

Multipurpose machines have different layouts with one or more spindles, multi-positioned revolving heads and shops that contain 30 to 100 different cutting tools. Changing the tool in the spindle during the technological process takes place automatically within 4 - 6 seconds. The use of one such machine makes it possible to replace a number of milling, drilling and boring machines, while significantly improving the productivity by reducing the auxiliary time as a result of automation of the cycle of processing and automatic change of the cutting tool and the workpiece.

2 Aggregate machines

Aggregate machines are used to provide high performance in mass, mass production and serial production for the processing of complex and labor-intensive components: engine cylinder blocks, speed boxes, pump housing, and others. They are made up of unified nodes according to the processing route. Payback period of aggregate machines is 1-3 years. Aggregate machines are used for drilling, sewing, boring of holes, cutting of thread, rolling, grooving, chamfering, milling of planes, keyboards and others.

The increase in productivity on aggregates results from the concentration of transitions by applying multi-spindle and multilateral processing. Aggregate machines are combined in automatic lines with the use of transport and boot devices.

Aggregate machines consist of a frame, power heads, a fixed or rotary table for the installation of equipment and fixing on it the workpiece and controls.

The layout of machine tools from normalized nodes allows for rapid redesign when a processing object is changed.

In recent years aggregate machines have been equipped with programmable devices.

The sequence of the formation of technological indicators of parts in the processing of workpieces on aggregate machines is determined by the following principles of construction of technological processes.

1. The principle of the shortest processing route, which consists in the fact that the processing of each surface should occur at a minimum number of technological transitions and operations.

2. The principle of compatibility of the successive execution of technological transitions in the processing of one and the same surface, which consists in the fact that the values of quality indicators at the input of each subsequent transition (operation) should be equal to the value of the same indicators at the output of the previous transition.

3. The principle of refinement of the workpiece in the processing process is that each subsequent transition (operation) should be more precise than the previous one.

4. The economic principle of constructing a technological process is to minimize the costs of living and social labor for a given volume of release of products and production conditions.

The productivity of machining aggregate machines versus universal equipment increases tenfold. In mass production, the reduction of the cost of the technological process of machining and increasing productivity is achieved by combining aggregate machines and automatic lines into a single transport system, as well as the creation of automated sections, workshops and factories.

In the mass production, the most progressive is the creation of integrated systems, which are a set of CNC machines (including machined centers), which are connected by the general transport system and have automatic control devices, interoperable storage warehouses, devices for orientation and fastening of workpieces on the machines and their changes. The whole complex of equipment of the integrated system is controlled by the general computer according to the given program.

3 CNC machines

CNC machines, according to their technological capabilities, are divided into three groups.

1. Milling machines are designed for processing complex contours of body parts, templates, stamps, etc. They carry out a comprehensive processing, including milling, boring and drilling operations.

2. Machine-tools of drilling-boring group perform drilling, winding, turning and boring.

3. Machine-tools of turning group process parts of rotational bodies with rectilinear and curvilinear contours, crush complex internal volumes of cavity, cut external and internal carvings.

The machine tool industry produces the following types of CNC machine tools:

1. Turning group - lathe screwdriving, lathe-revolver, lobotokarnye, turning-carousel, one-and two-stops with different number of servitors.

2. Milling group - console-milling horizontal and vertical; vertical milling, console with a cross table; longitudinally-vertical vertical dual with vertical ladder, with a rotary mobile and non-mobile table.

3. Vertical-boring group - vertically-drilling one-stroke with a cross table and a revolving head, a double-stroke with a revolving head; horizontal boring with non-movable forward riser and a cross table, with a longitudinally mobile riser and a cross-movable turntable, as well as a longitudinal and cross-connecting riser.

From the experience of the operation of CNC machines, it is known that when processing certain parts, their efficiency is rather high, and in the processing of others - insignificant. Thus, the effectiveness of using CNC machines depends on the design and technological features.

The main feature of CNC milling machines is automation of all shaping and auxiliary movements and tool change, cutting modes, adjustment of tool placement, etc.

For high-performance milling of the plane on CNC milling machines, finger cylindrical, spherical, end and disk cutters are used.

When you base the workpieces on CNC milling machines, in all cases it is necessary to deprive them of all degrees of freedom relative to the zero point. Basing should ensure a unique position of the workpiece on the machine when machining all its surfaces. It is desirable to ensure the principle of interconnection of databases. When machining the planes located at an angle, angle plates are used with a constant angle of 90 ° or universal, allowing a turn at any angle around one or two axes. For fastening of parts used brushes of different designs: simple irremovable, rotary around one or two axes and special with manual, pneumatic, hydraulic or pneumo-hydraulic actuator.

Depending on the configuration of the holes of the permissible accuracy, shape and mutual arrangement of the axes, processing them on CNC machines from the drill-boring group is performed according to a certain set of technological transitions. Each set of technology corresponds to a set of tools. If the number of positions on the machine is less than the required number of tools, then the combined tools are used or the processing is split into two operations. During processing of body parts with a large number of holes, two processing options are possible: parallel, when all holes are first processed by one tool, and then it is replaced, and the cycle is repeated, and consistent when each hole is treated with the required set of tools according to the technological scheme, after which positioning is performed for processing the next hole. Technological transitions of processing of openings are executed according to typical schemes.

4 Requirements for machinability of body parts and workpieces processed on automated machines

When developing the manufacturing process of the body detail, it is necessary to analyze the design of the body part in terms of its technological and features of processing on automated systems.

The most technologically considered design of the body detail, which meets the following requirements:

- the availability of convenient technological bases that provide the desired orientation and reliable fastening of the workpiece on the machine with the possibility of processing it from several sides and the free supply of the tool to the treated surfaces;

- Simplicity of the geometric form of the workpiece, which allows to handle most of its surfaces from one installation;

- the outer surfaces of the parts should be of an open shape, which ensures the possibility of processing in the direction of flow;

- The treated surface of tides and plaques on the appropriate external sides is desirable to be located in the same plane;

- in the design of the part, it is necessary to remove the machined surfaces of the sloping position, the sections of the shaped profile, the complex ledges and grooves that interrupt the flat surfaces and openings;

- the main openings, which require high accuracy, need to be done through the minimum number of stages, which allows to process the process with a smaller number of tools;

- openings that are located on one axis in opposite walls, it is desirable to perform one diameter;

- if there are several openings on the same axle, their diametrical dimensions should be reduced from the outer wall to the middle of the part; The most accurate openings are desirable to be located on the outer walls;

- the holes must be arranged perpendicular to the flat surfaces; in the presence of sloping holes, they should be available for handling when rotating a rotating table with a fixed workpiece;

- in the design of the part, it is necessary to remove the treatment of the internal end surfaces and bobs that require interruption of the cycle and the installation of the tool inside with the absence of special radial feed mechanisms;

- the workpieces of the workpiece must be located in accessible for processing planes, which can be turned to the spindle when the table is rotated gradually to the workpiece at a certain angle;

- it is desirable to have the mounting holes of the same size with the possibility of threading them with the taps, allowing the use of standard processing cycles;

- the workpiece must have sufficient rigidity and strength, which eliminates the possibility of vibration during the processing or unacceptable deformations from the cutting and fastening forces.

In the analysis of technological capacity, it is necessary to take into account the features of software machines and multi-purpose machines. These features are determined primarily by the layout of the machine, the presence of a rotary or globe table, the presence of molded slabs and other technological equipment, as well as the coordinate system adopted at the machine.

When manufacturing the body part on a CNC machine, it is necessary to recalculate the dimensions that determine the accuracy of the distance and relative rotation to a single coordinate system that corresponds to the adopted complex of technological bases. When machining on CNC machines, the trajectory of the relative movement of the workpiece and the cutting tool is formed by the teams at the reference points given in a rectangular coordinate system. Accordingly, the dimensions in the drawings need to be specified in a rectangular coordinate system.

In the general case, placing the dimensions on the drawings of parts that are processed on automated systems should be such that, in the preparation of the control program, the need for their conversion was the smallest.

The processing of billets with large assumptions on precise and expensive machines, which are multi-purpose machines, is not beneficial. This is due to the need to preserve the high accuracy of multi-purpose machines, the demand for the most efficient use of expensive equipment and the specifics of the technological process at automated sites.

In the conditions of automated production, the division of operations performed on the same machines, on roughness and finishing, as well as the interruption of the automatic cycle in order to carry out the artificial aging of the workpiece, is highly undesirable. The operation of artificial aging must be carried out in the first stages of the technological process until the case arrives at the automated site.

The workpieces of body parts, which are processed at automated sites, should be sufficiently precise and have relatively small admissions, which meet the conditions of semi-finished and finishing. These requirements correspond to the casting of the first and second part of the second grade of accuracy.

The use of coordinate-measuring machines in the manufacture of body parts in flexible automated production allows you to remove the marking operation by performing the desired orientation of the workpiece when attached to the satellite for the first operation. Marking bases in this case act as technological bases, which are used to establish procurement on the satellite.

5 Features of the technological process of processing billets of body parts on automated machines

Construction of the technological process of manufacturing billets of body parts on multi-purpose machine tools and automated sections has its own peculiarities. Identifying and taking into account these features is of fundamental importance for achieving the required precision of the part and efficient use of expensive machine tools.

One of the main features of the construction of technological processes on multi-purpose machines and automated sites is the maximum concentration of technological transitions that are consistently executed under the program using a different cutting tool with the fullest use of the principle of unity of the bases. The main technological advantage of this is the achievement of high accuracy of the relative positioning of the surfaces of the parts, which are processed from one installation usingand various cutting tools.

The use of multipurpose machines and automated sites greatly enhances the possibilities of complete processing of workpieces from one installation when it is based on untreated surfaces. The structure of the construction of the technological process is greatly simplified. The complete processing of the workpiece can be performed on one or several (two, three) multi-purpose machines. The batch is processed without re-attaching it to one satellite, which successively moves from one machine to another.

If the processing of the workpiece from one installation is not possible, the structure of the implementation of the technological process consists of the following steps:

1. Treatment on the first operation of a complex of surfaces, which are used in the future as technological bases, to obtain most of the surfaces of parts.

2. Treatment of practically all surfaces of the workpiece from the common technological bases obtained during the first operation.

In many body parts, several identical surfaces may be located on one side, for example, the surfaces of openings of the same diameter, grooves of the same width or planes of the same size. In this case, it is advisable to use one tool to consistently treat all the same surfaces, and then change the cutting tool.

In the presence of uneven or overpriced milling on planar surfaces, it is recommended that the milling be carried out in successive working steps using smaller milling cutters.

In order to reduce the impact of the drill, in order to achieve the accuracy of intercentric distances and hole placement, it is recommended that the centering be performed. It is advisable to use simple multi-spindle drill heads to handle a group of mounting holes. In turn, stepped openings for increasing productivity need to handle customized cutter blocks or combined zenckerami.

When processing holes in cast billets, it is recommended that the cutter be first used instead of chopping. This allows you to reduce the deviation of the axis of the hole due to uneven dropping. For the removal of the axis of openings of large diameter (more than 100 mm) as the first transition, it is recommended to mill the contour with the final cutter, and then the boring.

For the guaranteed achievement of the required accuracy of the placement of a number of openings and planes relative to one base, all these surfaces need to be processed on one machine for one installation.

In order to reduce the range of the instrument, it is necessary to increase the requirements for unification in the prescribed diameter of the holes and fastening threads in the body parts.

The routine technological process of processing body parts on multi-machine tools is developed taking into account the processing features of CNC machines, technological capabilities of these machines (including accuracy and processing performance) and their cost.

The concentration of processing conversions in operations performed on a multi-processor CNC machine allows to reduce the number of operations, the complexity of processing, and to increase the accuracy of the relative positioning of parts surfaces.

In the routine process of processing the body detail, which is subject to artificial aging or having precise openings and planes, it is necessary to differentiate the operations on the rough and clean. In such cases, the body parts are manufactured for one or two roughness and two finishing plants. Two roughing (clean) installations can be combined into one single (clean) operation using multi-use devices.

In the routine processing process of the body parts that are not subject to aging and (or) which do not have precise openings and planes, as a rule, there are two or one machining operations on a multi-tool machine, depending on the number of machined sides and their accuracy. For complex details, a marking and placement operation that determines the location of the part must be provided. Most of the locksmith operations, including manual threading, are removed.

If the body piece is subjected to intermediate heat treatment or has precise openings and planes, then the route process is recommended as follows.

1. The first draft operation is the processing of parts from two sides (planes and openings of large diameter); As a technological base, surfaces are used to provide reliable fastening, the possibility of productive withdrawal of lubrication.

2. The second draft operation is the processing of the other parts of the part with the installation of surfaces processed in the previous operation, the formation of technological bases for the subsequent treatment. In each of the roughing operations, it is necessary to process interconnected planes and openings to ensure a minimum rejection for the next treatment, to remove the maximum amount of material to stabilize the internal stresses.

3. The first finishing operation is the processing of the base and opposite to it the planes of the workpiece and all the elements (grooves, ledges, openings) located on these planes, including the main openings.

4. The second finishing operation is the processing of the other four sides with the installation of the bases processed in the previous operation, including the treatment of the main openings, grooves, ledges, auxiliary and fixing holes.

The operational technology of the processing of body parts on multi-tool drilling and milling machines with CNC is developed on the basis of the following.

1. Operation processing - a set of transitions processing of individual, elementary surfaces of parts.

2. Technological transitions of the processing of an elementary surface (hole, plane, groove, etc.) are chosen according to the worked out technological schemes. The technological scheme is a complex of successive transitions necessary for providing the required surface quality.

3. At the beginning of the operation, the external and internal contours are molded by end, end and other milling, then the main and auxiliary openings of large diameter are machined, and in the end, the auxiliary openings of small diameter.

4. Based on the operating conditions of the machine and ensuring the accuracy of the processing, the operation is designed with the minimum amount of tool changes and turning tables with the workpiece.

5. As the first transition of cast holes on machines with a positional control system, it is necessary to use boring, not zenkeruvannya, because the boring of the displacement of the axis of the working hole is much smaller. On machines with a contour control system in this case, for openings of large diameters, it is expedient to use milling instead of boring, since the final milling is much less sensitive to uneven application to the treatment.

6. The main openings and other parts of the surface, the precision of the size and relative positioning of which is stipulated by rigid tolerances, is treated with successive replacement of tools with minimal changes in the relative position of the part and tool.

7. Base surfaces (three planes or a plane and two openings) must be processed in one installation. If other operations are performed on the same operation, then to exclude the influence of the deformation of the part in the processing on the accuracy

of its base surfaces, these surfaces are treated at the end of the operation after the technological stop of the program and re-pressing the part.

TECHNOLOGY OF SHAFT PROCESSING

Service appointment and classification of shafts

The details of the class "Shafts" include shafts, rollers, axles, fingers, hubs, etc. Shafts are designed for the transmission of torque and mounting on them with the necessary precision of various parts.

Figure 9 - 3D - the model of the primary shaft of the distribution box

Shafts between themselves have certain differences in official design, constructive shape, size and materials. In the general engineering, there are shafts continuous and stepless, solid and hollow, smooth and split, shafts with flanges, shaft gears, as well as combined shafts, which have a diverse combination of surfaces of parts from reduced groups.

In shape of the geometric axis, the shafts can be straight, crank and eccentric. Depending on the size and weight of the shafts are conventionally divided into heavy ones - in diameter more than 200 mm and weighing more than 1 ton; large - in length more than 1 m and diameter up to 200 mm; medium - up to 1 m in length and small - in length up to 150 ... 200 mm.

Geometrically, shafts are a combination of cylindrical, tapered, threaded, toothed, slotted, and key surfaces. In stepping shafts, when moving from one step to another, grooves or grooves are foreseen. Felting is a more complex operation than processing grooves. Therefore, to improve the production efficiency of the surface of the transition between the steps, it is recommended to make it in the form of grooves. At the same time, in terms of increasing the fatigue strength of shafts, the use of galtles is more expedient.

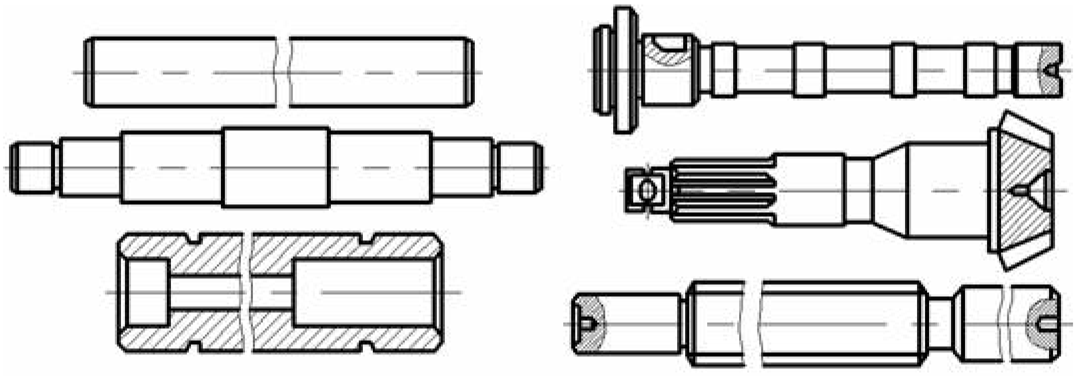


Figure 10 - Variety of shafts (combination of different types of surfaces on the shafts)

By accuracy, shafts are divided into four groups:

1 Shafts are especially accurate - the working cranks of these shafts are manufactured with an accuracy of 4-5 grade of accuracy; other surfaces with tolerances for 6-7 grade of accuracy.

2 Precise shafts - the main working surfaces are made by 6 qualities of accuracy, and the rest of the surfaces are 8 grade of accuracy.

3 Shafts of normal accuracy - the surfaces of these shafts perform with an accuracy of 8-9 grade of accuracy.

4 Shafts of reduced accuracy - the dimensions of the main surfaces of shafts are manufactured with an accuracy of 10-14 grade of accuracy.

Technical requirements for shafts. Based on the service purpose, the following basic technical requirements are put forward to the shafts.

1. The diameters of the landing necks for rolling bearings should be processed in 5-6 grades with roughness of the surface Ra = 1.25 ... 0.32 microns, and under the bearings of slip - on 9-11 qualities with a roughness of the surface Ra = 2.5. ..1.25 microns.

2. Oval and taper crankshafts must be within the tolerances of their size.

3. Centrifugal surfaces of the slice section are treated in 9-12 qualities with roughness of the surface Rz = 40 ... 50 microns; the deviation from the parallelism of the shaft grooves or slots relative to the shaft axis shall not exceed 0.1 μm / m in length.

4. The tolerances for the length of the steps must be within the range of 50-200 μm, and the curvature of the shaft axis - from 0,03 to 0,05 mm / m;

5. The beating of the centering diameters of the hinged surfaces and the necks of the shafts under the bearings relative to the one and the other is allowed within 0,04-0,05 mm, and with respect to the common axis - no more than 0,05-0,08 mm.

6. Mutual beats of working and non-working necks of shafts shall not exceed 0,1-0,2 mm.

7. Unplanned surfaces are processed in 14 qualifications.

8. The ends of the shaft should be provided with chamfers.

For most shafts, the main thing is to ensure the coherence of the working surfaces, as well as the perpendicularity of the working faces of the base surface.

Shafts can be raw and heat-treated. The hardness of the surface layers, the method of heat treatment can be quite varied depending on the purpose of the shafts. If the value of the hardness of the shaft surface does not exceed HB 200 ... 230, the workpieces are normalized, annealed or thermally treated. To increase the wear resistance of the shafts increase the hardness of their working surfaces. Often this is accomplished by surface hardening of high frequency currents, which provides the hardness of NRS 48 ... 55. The surfaces of low carbon steel shafts are cemented to a depth of 0.7 ... 1.5 mm with subsequent hardening and release. In this way, the hardness of the NRC 55 ... 60 can be achieved.

In addition to the shafts are put forward and certain specific requirements for the technological.

1 The diameters of the stepped shafts should be minimal. It allows to reduce the volume of mechanical processing during their manufacture and to reduce metal waste. For this reason, the design of the shaft with grooves and spring rings is more technologically advanced than the construction of a shaft with drills.

2 It is desirable to design the lengths of shaft stages in equal or multiple lengths of short degree, if torque processing of shafts will be carried out on multi-turning machines. This design allows you to simplify the settings of the cutters and reduce their unplugged displacements.

3 The shaft and threaded sections of the shafts are desirable to be constructed open or end with grooves for the output of the tool.

4 The grooves on the shafts need to set one width, which will cut them with one cutter.

5 The center holes must be provided in the shaft design. In the absence of the center holes sharply reduced the machinability of the shaft. In such cases, it is necessary to significantly increase the length of the workpiece in order to enable the production of temporary centers that are cut off at the end of the processing.

Material and shafts workpiece. Shafts are mainly made of structural and alloy steels, to which the requirements of high durability, good workingability, low sensitivity to concentration of stress, ability to undergo heat treatment. The listed requirements correspond most closely with steel grades - Steel 35, 40, 45, 40Г, 50Г, 40Х, 35ХС, 40ХС, 45ХНМ 35СГ 38Х2МЮА and other. Most often used steel 45 and 40Х.

The productivity of machining shafts largely depends on the type of workpiece, its material, size and configuration, as well as on the nature of production. The workpieces of shafts are cut from hot rolled or cold drawn normal rods and are directly subjected to machining. For large shafts and spindles, cast castings are used.

Depending on the type of production, design and size of the shafts for the billets, they use rolled solid cutting, forging, stamping, special pipes and castings. The main requirements for shafts - good straightforwardness and minimum allowable processing.

In production with a significant scale of production, as well as in the manufacture of shafts of a more complex configuration with a large number of stages, which vary greatly in diameters, the workpieces should be obtained by the method of plastic deformation. These methods (forging, punching, periodic rolling, bending on rotational forging machines, dismounting) allow you to get billets, in shape and sizes, closest to the finished parts (Fig. 3), which greatly increases the machining performance and reduces the metal capacity of the product.

The choice of the most rational way of obtaining a workpiece in each individual case is determined comprehensively, taking into account technical and economic feasibility. With the increase in production volumes, the efficiency of using the metal and reducing the complexity of machining are of particular importance.

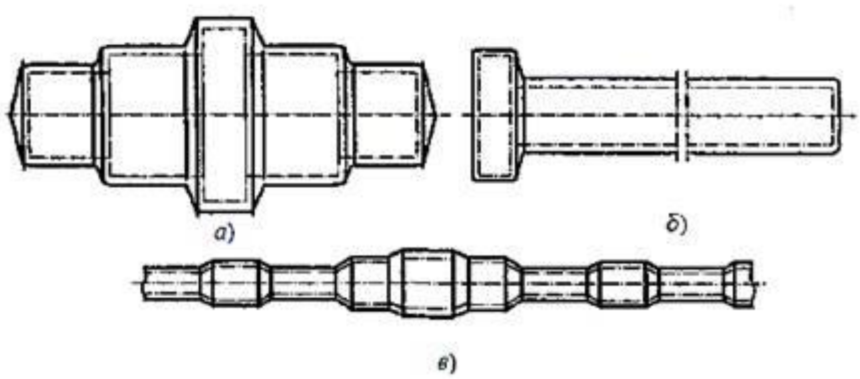


Figure 11 - Billets, obtained by the methods: a - stamping in the dies; B- stamping on a horizontal-forging machine; in-cross-screw rolling

Therefore, in large-scale and mass production prevailing methods of obtaining billets with a coefficient of metal use from 0,7 and above, which in individual cases reaches 0,95. Hollow shafts should be made of pipes.

In most cases, for shafts, the diameters of which stages differ a little, the workpieces are cut off from the rolling material. For shafts, the diameters of which stages differ by more than 10 mm, the workpieces are cut off from the rolled stock and then hammered or hammered in laminated or closed die.

Sometimes the workpieces are pressed on the rotary-forging machines, and then they are machined on the machine tools. For long, smooth shafts, it is advisable to use cold-drawn steel blanks.

In the stockpile or tin, the rolled bars are stamped, rolled, cut, centered. Forging and stamping are also undergoing blacksmithing operations: milling and centering of ends (ends), rust and preliminary boring of openings.

Preparation operations for bars are generally executed in the following order: 1- editing; 2- centrifugal clearing; 3- Cutting; 4- Centering (if the rod is handled on a revolving machine or automatic machine, then the centering is not carried out); 5- control of performed operations.

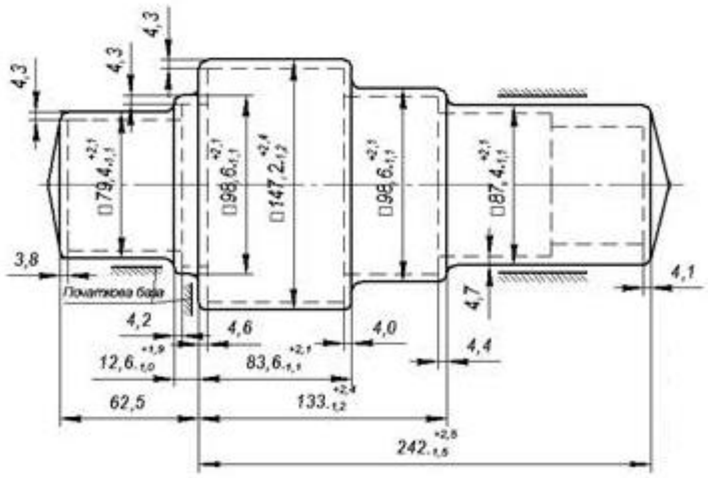


Figure 12 - Preparation of shaft-gear (forging)

Rods and workpieces are operated on hand, screw, eccentric, hydraulic, pneumatic and friction presses.

A large number of rods are operated on special machines.

For striping rods apply centrifugal-rigging machines. On them it is possible to make a stripping of bars in diameter from 15 to 80 mm, in length 7 m. The blasting is carried out by rotating two incisors, the feed rod is carried out by two rollers having a nodal.

The rods are cut on drive knives, on saws (disk, tape, friction, electro-friction), on turning-off machines (with one or two cutting cutters), cut-off machines, machine tools working with thin abrasive wheels (for cutting hardened steels and pipes) The rod material can also be cut on presses and scissors.

Technological base. The technological bases of the main number of shafts are the surface of the supporting necks. However, using them as technological bases for the processing of external surfaces is usually difficult, especially if the rules of the unity of the bases are observed. This is especially important when automating the process of machining shafts.

Therefore, for most operations for technological bases, take the surface of the center holes from both ends of the workpiece. This allows you to handle almost all external surfaces of the shaft using a single base with a shaft mount in the centers. The shape and size of the center holes are standardized. There are several types of center openings, of which three are most commonly used for shafts.

In this regard, rough bases take rough external surfaces. Pure base - center holes or center hinges for hollow shafts.

To eliminate the error of the base when maintaining the length of the steps from the end of the shaft, it is necessary in the role of the technological base to use the end of the workpiece. For this purpose, the workpiece is set on a floating front center.

In some cases, the processing of precise hollow shafts and spindles is carried out on special cork (openings), where the base is precisely processed internal conical or cylindrical openings.

When milling, milling, milling, drilling operations, when installing a shaft on a prism, as base surfaces, the bearing cams under bearings or cranks are used, on which the gears, couplings, pulleys, etc. are planted on the shaft.

The structure of the technological process. The typical technological process of manufacturing rolls of rolled products includes, in various combinations, the following operations: straightening, stripping and cutting; treatment of center openings; dredging and clearing; drilling and boring of the central opening; threading; milling of slots, keyhole grooves and linen; teeth cutting for gear shaft; drilling of radial openings; heat treatment; blunt and clean grinding of cervix, teeth, slots and threads; Finishing treatment of landing surfaces: superfinishing, rubbing and polishing; size control.

Editing, cutting and stripping of rolled metal. Reducing rolled metal with a diameter of more than 50 mm is carried out on presses with a plastic change-over bend. The rods of a smaller diameter are driven on rollers with a longitudinal feed of rolled stock without rotation or with a screw rolled feed. In the latter case, the correction is made by rollers of the globose form, which are located at an angle to the axis of rolled. When rotation of rollers, the workpiece receives translational and rotary (screw motion).

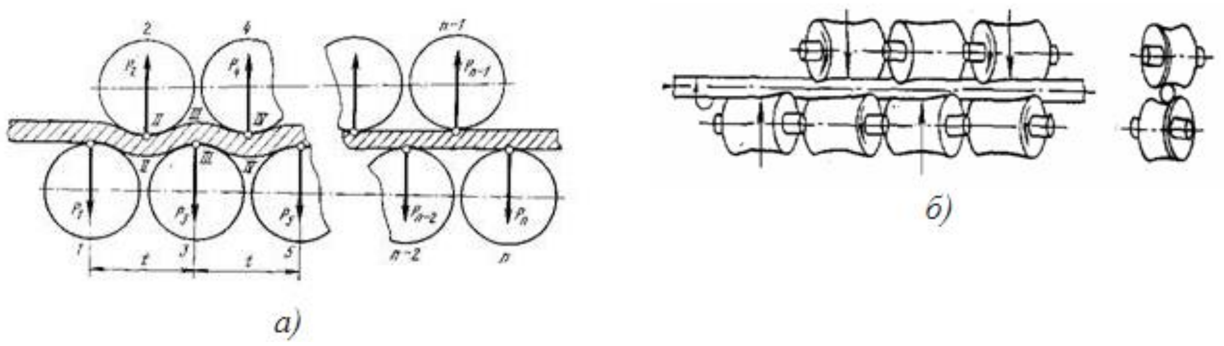


Figure 13 - Schematic of the rolled-up rotation with a replaceable bend on roller machines: a - with a longitudinal feed without rotation; B - with a screw feed

Chipping (rough boring) is carried out in order to remove the defective layer. Stamina is carried out on non-center lathes.. The machine works in this way. The workpiece (rolling) without rotation is supplied by rollers 1 in the cutter head with cutters 2, 4 and crackers 5, which exclude the deflection of the workpiece from the cutting force. The heads are mounted on the faceplate on the input and output for roughing and finishing rigging. The flatbed rotate with the toothed wheel 3. The cutting process is carried out by rotating the cutters around the workpiece.

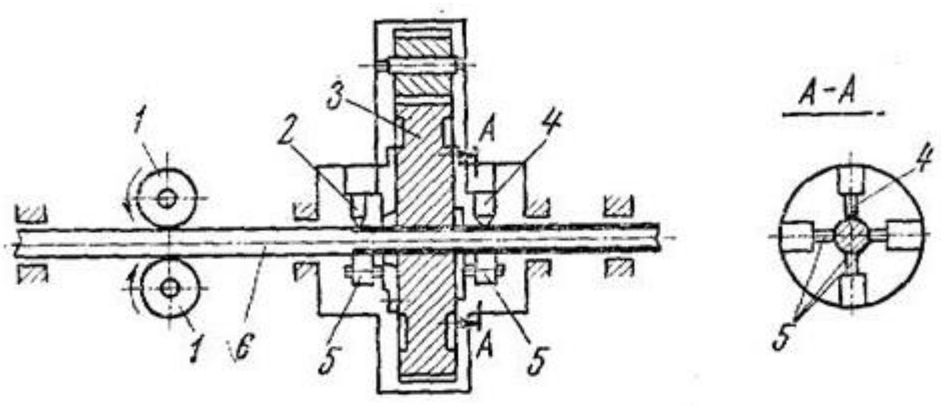


Figure 14 - Scheme of centerless machine

Cutting is carried out on drive knives; saws: disk, ribbon, friction, electric friction, with abrasive disc; on turning-cut machines; scissors, presses The drive knives are cut by a knife blade, which is pressed by the cutting part before the rolling and makes reciprocating motions from the mechanical drive. Schemes of cutting by rolling and band saw are presented in fig. 8. The band saw is an endless ribbon with teeth stretched to discs, one of which is drive.

Cutting by a friction saw is carried out due to friction forces. The saw is a thin steel disc that rotates at speeds up to 150 m / s. When in contact with the metal, it fats from the friction and melts.

Cutting by an electric friction saw is carried out due to the joint action of friction and electric arc, which is ignited when connecting the saw and rolled to different poles of the source of electric current.

The scheme of cutting of rolled metal on a turning drilling and cutting machine is presented in Fig. 15.

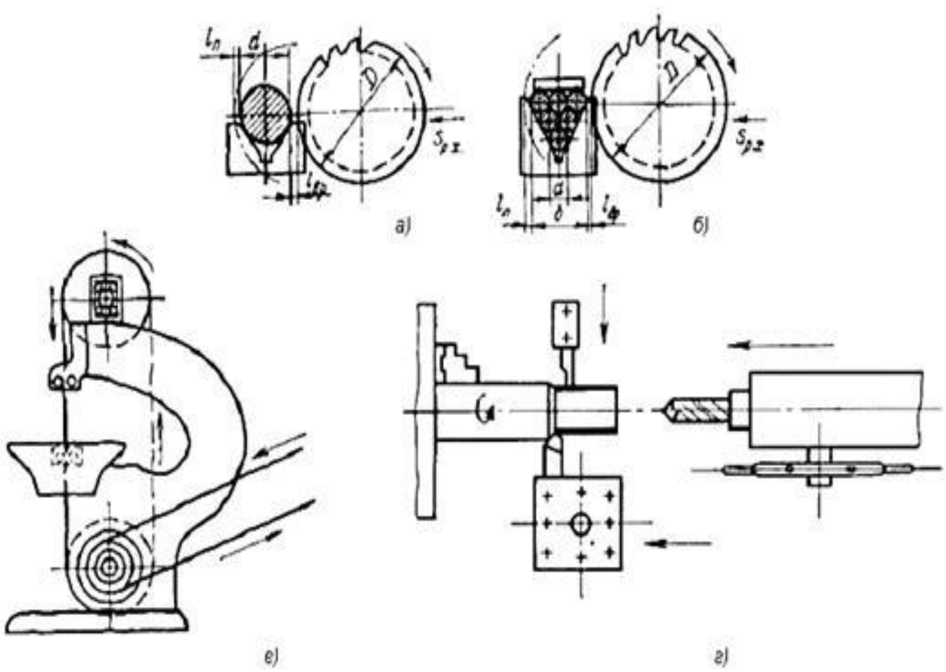
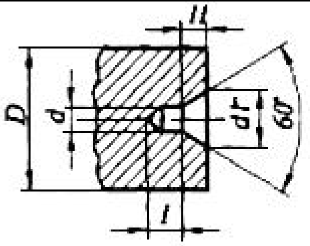
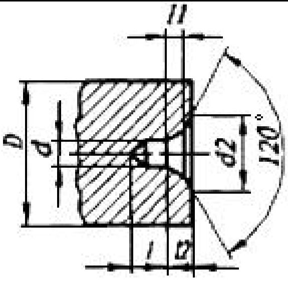
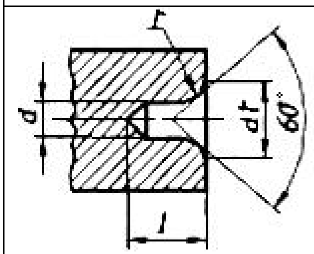


Figure 15 - Cutting of rolled stock: a - disk saw of one rod; B - disk saw block of rods; in - a band saw; g - on a turning drilling and cutting machine

Treatment of center openings. In the manufacture of shafts, the center holes are a technological base for a number of operations: turning, threading, threading, slotting, checking, etc. Types of center openings and the tool for their processing are shown in the table. 1 and on fig. 16.

Sketch	Marking	Purpose
	A Without preventive cone	Products after processing which need in the center holes disappears
	B With preventive cone	Products in which the center holes are a base for repeated use are stored in finished products
	C With arched shapes	Products of high precision

In small-scale production, in the absence of special equipment, the center holes are machined on lathes for two institutions. First, cut the end face and drill the hole on one side, then reinstall the workpiece and repeat the transitions. When changing the bases due to the reinstallation, there is an error in the location of the axes of the center openings, which may affect the accuracy of further processing.

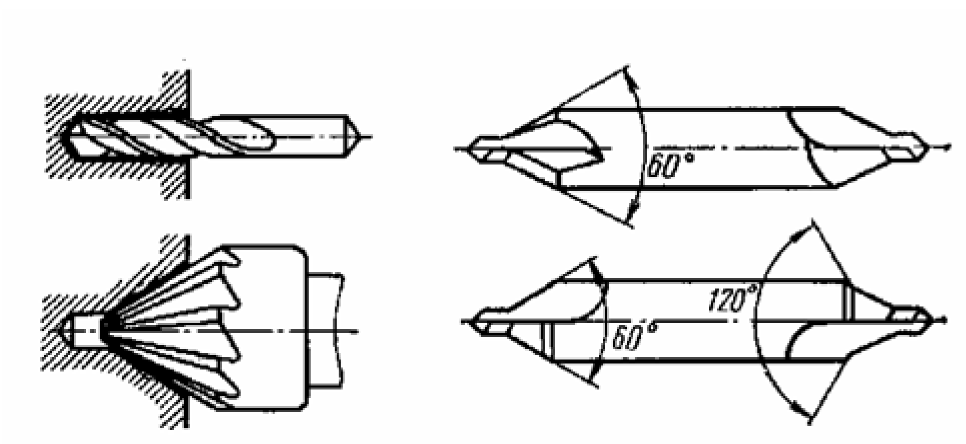


Figure 16 - Tool for processing the center holes

In large-series and mass production for machining center openings, milling-centering semiautomatic devices are used. The machining scheme on these machines is presented in Fig. 17a. Shaft is fixed in prisms. In the first position, the end mills handle the ends of the workpiece, in the second position drill the center holes. Also used are machines, equipped torckecid cutter tool, which simultaneously is done trimming the end and drilling a hole (Fig. 17 b).

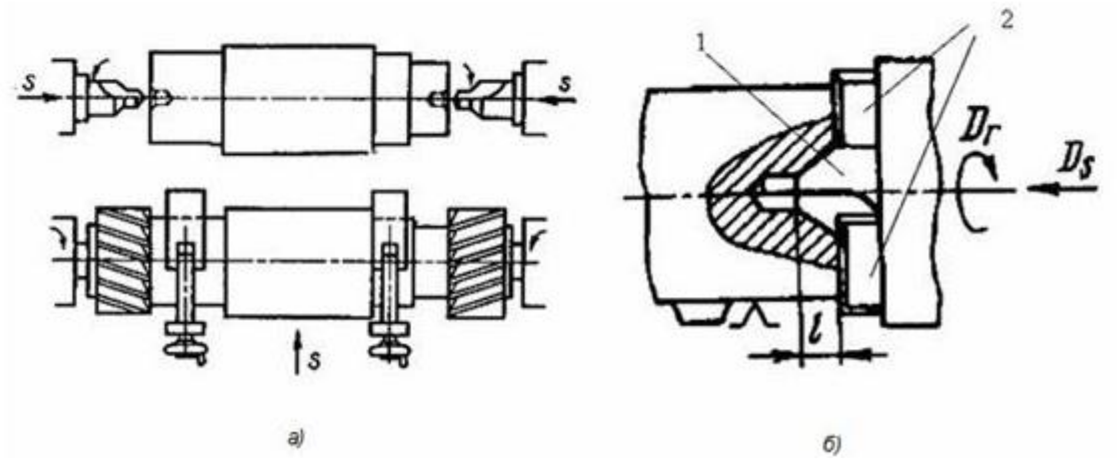


Figure 17 - Circuits for machining center openings: a - on a milling center machine; b - with the use of the end cutting tool; 1 - drill bit; 2 – cutters

Turning machines of different design for machining shafts are used in large-scale and mass production.

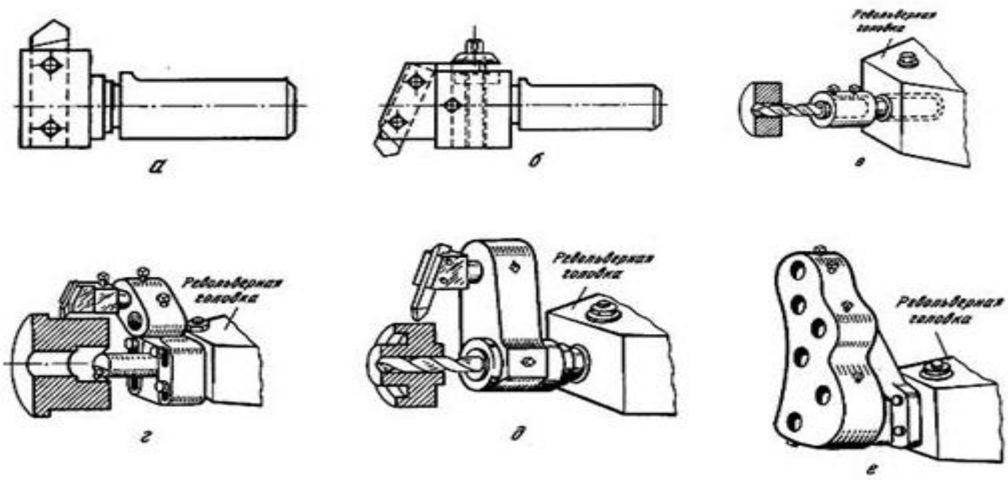


Figure 18 - Holders for lathe revolving machines: a, b, c - one-seater; g, d - combined; e – multidimensional

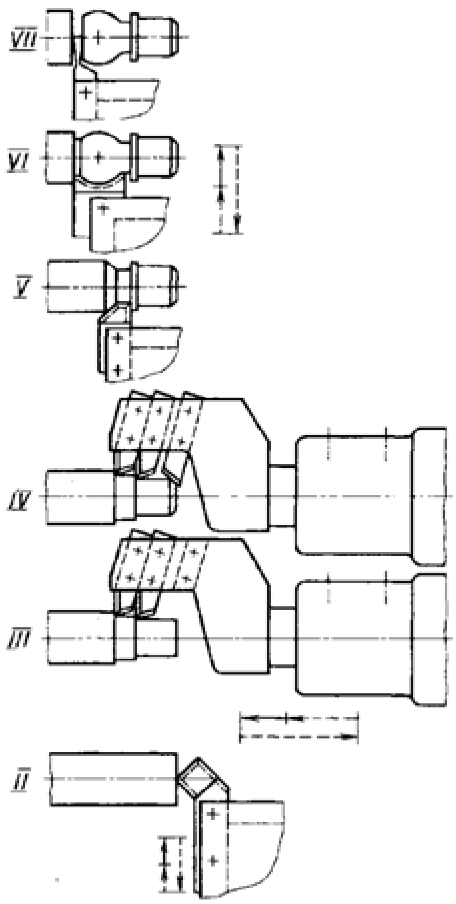


Figure 19 - Scheme of processing the ball finger from the bar material: I - unscrew, feed it to the end and secure the rod (not shown); II - to trim the end face; III - to sharpen the rod in two diameters pre-arranged; IV - to sharpen a rod on two diameters finally and to remove a chamfer; V - sharpen the neck; VI - sharpen the finger in the sphere; VII - cut off the detail

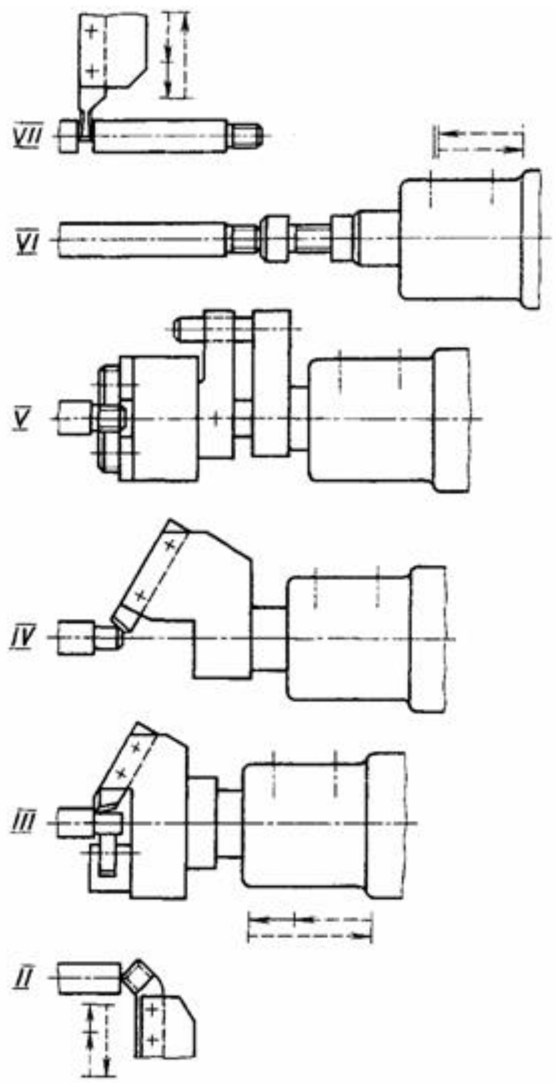


Figure 20 - Scheme of machining the threaded finger from the rod material: From - unscrew, apply to the stop and with a small outlet, secure the rod (not shown), and - cut the tip; III - sharpen the end under the thread; IV - to remove the chamfer; V - cut the thread, YOU - apply the rod to the length of the stop and fix the rod; VII - cut off the detail

Shaper machines have two to four supporters with shaped and cut-off cutters 2 working with a cross-feed.

The details are made from rod 1, which is fed by the mechanism of feeding to the stop 3 and fixed in a collet cartridge. Automatic machines are used for manufacturing parts from a wire with a diameter of up to 10 mm, rolled into a bay. The wire 5 during the processing does not rotate and is periodically fed to the cutting area with the lever 7 using a fixed clamping device. After filing, the wire is locked with clamps 1, 4, 6 and is machined with shaped cutters, installed in the rotary head 3. Editing the wire in a clamped state is carried out by rollers 8 with the reverse motion of the sledge. On the machine-cutting machines, parts with a length of up to 100 mm are machined with low accuracy. Processing is done by cutting. However, some machines have longitudinal sharpening devices, as well as aggregate heads for drilling, thread cutting, and milling.

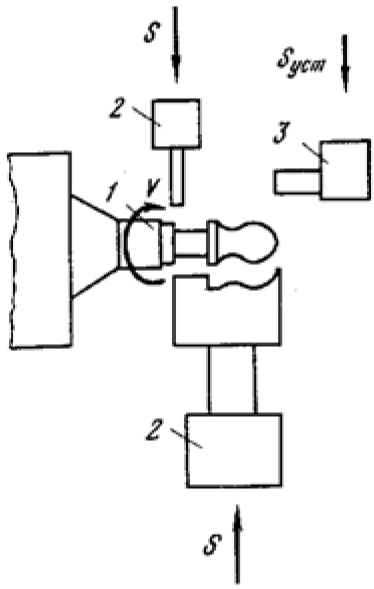


Figure 21 - Scheme of the work of the bar-shaped cutting machine

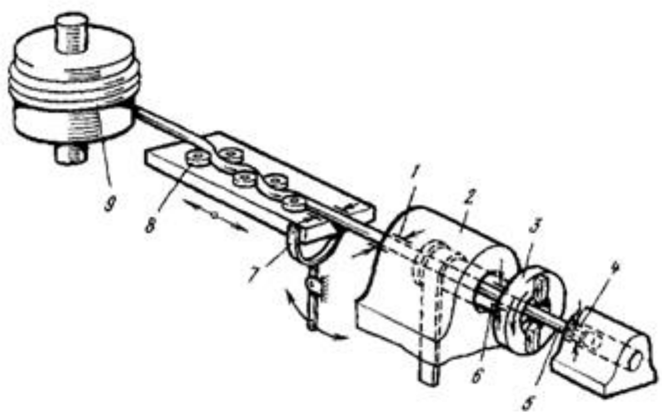


Figure 22 - Scheme of a cutting-edge automatic machine for the manufacture of parts from the bay

The machines of longitudinal sharpening are intended for processing of shafts from a cold-drawn bar, which is calibrated, from different metals in diameter up to 30 mm with an accuracy of 5-6 qualities in diameter and 6 qualities in length with a roughness of a surface 1,25 ... 5 microns. It is not advisable to carry out rough work on the machines of longitudinal towing to maintain their accuracy.

The scheme of the machines of longitudinal sharpening is shown in Fig. 23. A distinguishing feature of their work is that the bar 1, in addition to the rotational motion, has, along with the spindle 7, the translatory stroke Sp. Slider supports are fan-shaped relative to the rod. The upper calipers with cutters 4, 6, 8 have a transverse displacement of the Sop, horizontal 3, 11, arranged on the balancer 12, which has oscillatory motion, relative to the axis 13, and is actuated from the camshaft 2 of the camshaft. The cutting area of the cutters is close to the lunette 5, which is the support of the workpiece to be worked. The bending moment that arises, in this case, turns out to be very small, so the machines can receive high accuracy parts at a considerable length. The pusher 9, with the aid of load 10, constantly holds the rod pressed to the cutter after the cutting of the finished part when the spindle 7 is removed backward. At the simultaneously coordinated placement of a tower with a rod and incisors, the processing of conical and shaped surfaces without the use of shaped incisors is possible.

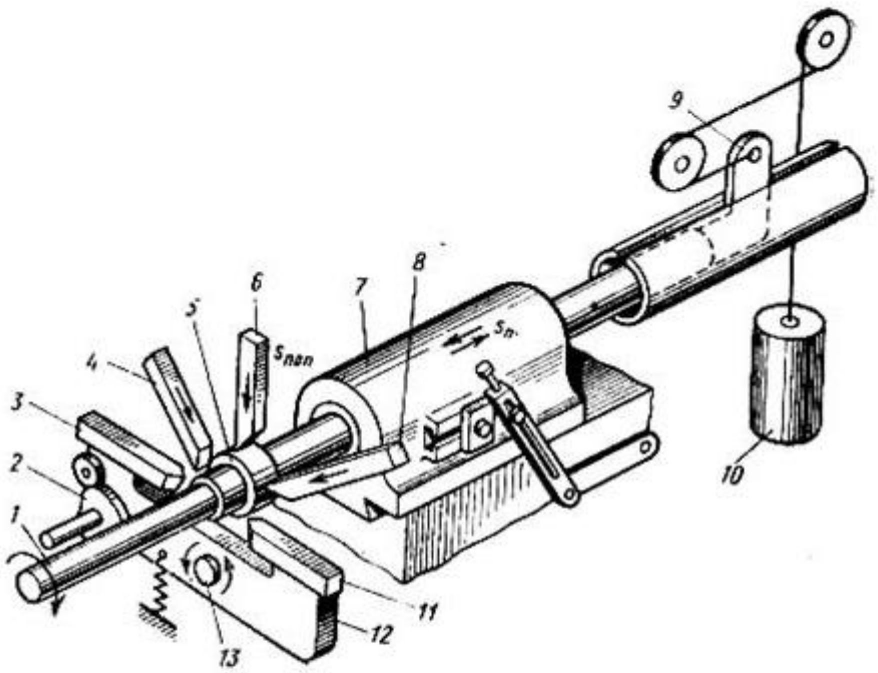


Figure 23 - Scheme of the boring machine of longitudinal feed

Fig. 24 shows the scheme of processing roller on a machine of longitudinal towing. Processing in positions 1-11 is carried out by successive alternation of the longitudinal displacement of the spindle rod with a rod and the transverse displacement of the incisors. In positions 12-13, the processing of the return cone and the segment of the finished part is carried out.

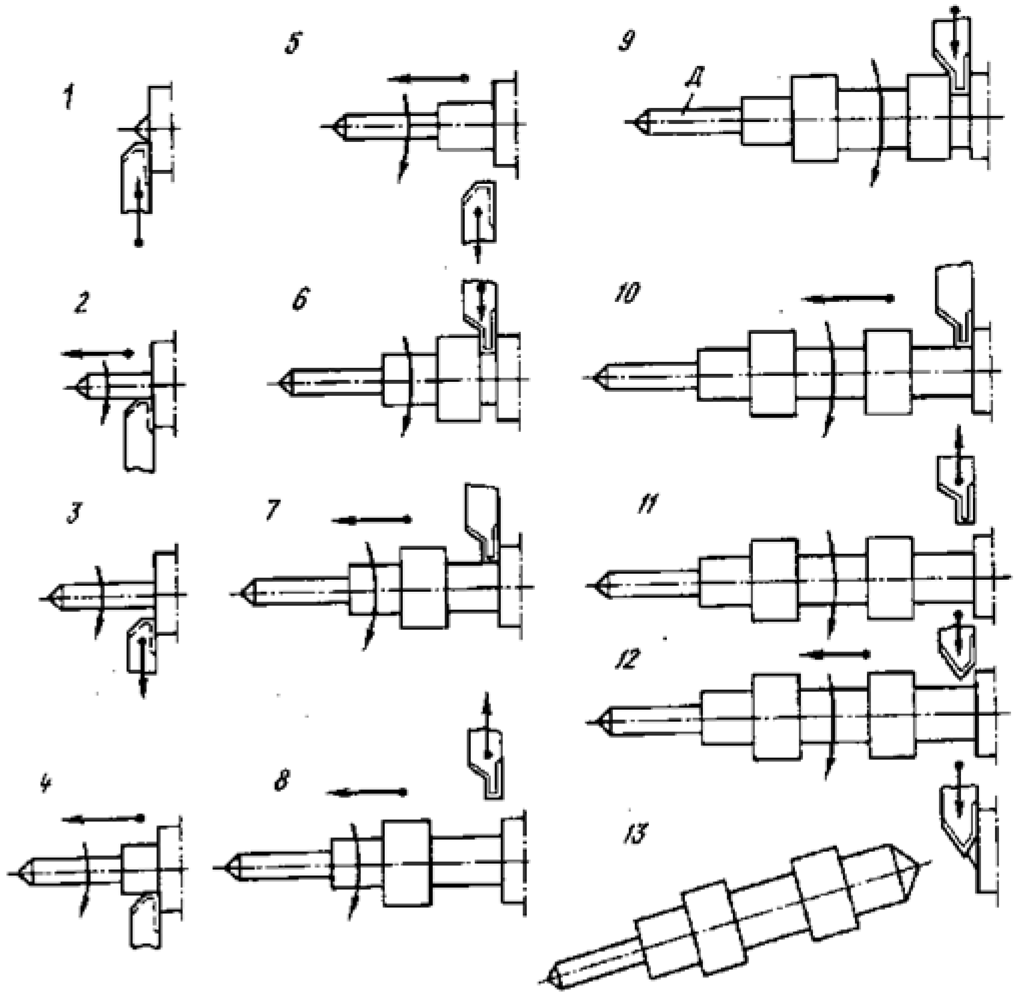


Figure 24 - Scheme of machining roller on a machine of longitudinal sharpening

Turning-revolving machines are intended for processing of details of complex form from rods in diameter of 10-63 mm. When equipped with automatic devices, boot devices can be used to process artificial billets. In addition to finishing the workpieces by turning and drilling on lathe-revolving machines, it is possible to cut the inner and outer threads, turn the conical surfaces, cut slices and even mill. To perform these operations, special adaptations and appropriate adjustment are required. It is not desirable to handle the use of hot rolled material, which leads to a decrease and faster wear of feeders and clamping mechanisms. The basic scheme of the machine is shown in Fig. 25. The bumper of spindle 1 of the machine is motionless. The front transverse caliper is detachable, and on the back and upper are usually cutters for processing grooves, chamfers, shaped surfaces, and so on. The control of the machine is carried out automatically from the cam camshaft.

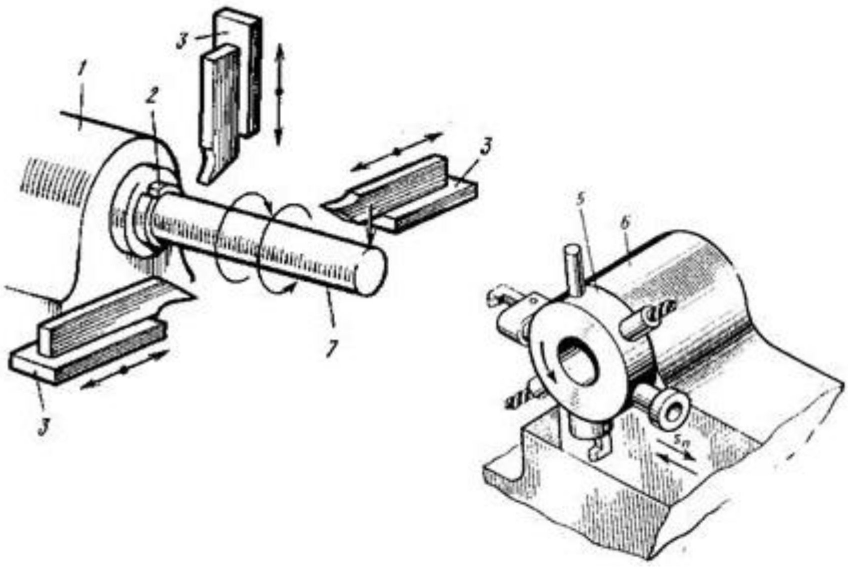


Figure 25 - Scheme of lathe-revolving machine

The workpiece (rod) 2 is fed to the desired length until the revolver head 5 stops, after which the processing begins. The cutters of 3 transverse portions have only a radial displacement (SOPP) and are intended for the groove groove, the removal of chamfers, the processing of shaped surfaces by a shaped cutter and sections of the finished part. The support 6 with the revolver head 5 has a longitudinal displacement.

Tools of the six-position revolving head turn one after its rotation, which can be done by threading, threading, drilling, winding and turning. Turning the revolver head to the next position occurs when the carriage leaves 6 ago. Preparation 2 can have left and right rotation. The presence of turning-revolving automatic machines of three or four transverse portions and a longitudinal support with a six-position revolving head extends their technological capabilities in comparison with the machines of longitudinal sharpening and allows them to receive on them more complex parts of the form. In addition, lathe revolving machines allow the use of special devices, which further increases their technological capabilities.

Lathe-revolving machines due to the presence of a revolver head and a bearing with them with several tools allow to perform a multi-tool processing, that is, several surfaces are simultaneously processed. This allows you to reduce the support time, but the number of manual techniques still remains high.

Multi-spindle lathes are intended for the manufacture of parts from rods in the diameter of 12-100 mm and lengths up to 160 mm. These machines (Fig. 26) have four, six or eight hollow spindles 6 which are located in one rotary unit 1. A rod is installed in the spindle hole and pressed with a collet cartridge. The axial displacement of the bar is carried by the feeding change. Each spindle has its own transverse caliper 2. The longitudinal support 5 moves along the guiding sleeve 4. This caliper is in the form of a polyhedron with the number of faces equal to the number of spindles. On the sides are clutches with different tools.

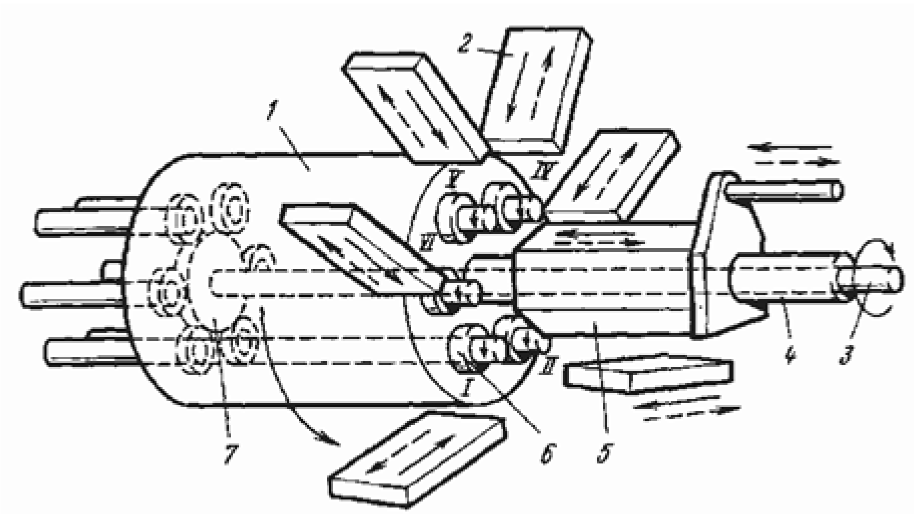


Figure 26 - Scheme of a multi-spindle lathe

When machining parts, the spindle block, along with the spindles, periodically returns from position to position. At each position, the transition is carried out, and at the last position is a segment of the finished part. The processing is carried out at the same time at all positions, so after each turn of the spindle block one item gets the finished part.

These machines have higher performance than single-spindle machines. They handle the more complex parts. However, the accuracy of processing on these machines is slightly lower due to the positioning errors of the spindle block.

Fig. 27 presents the scheme of treatment of a roller on a six-spindle machine. In position I of the longitudinal support, the drilling of the center hole and the degree of towing are performed. From the transverse caliper in the same position is the cutout groove. In position II, the groove is expanded with a shaped cutter. In position III, a shaped cutter is used, which performs the previous (semi-shaped) processing. For finishing (finishing) treatment at item IV a shaving shaper cutter and a support roller are used. In item V, the part is fixed on the other side of the chuck cartridge located on the longitudinal support. In item VI, the detail is cut off and centered on the other side.

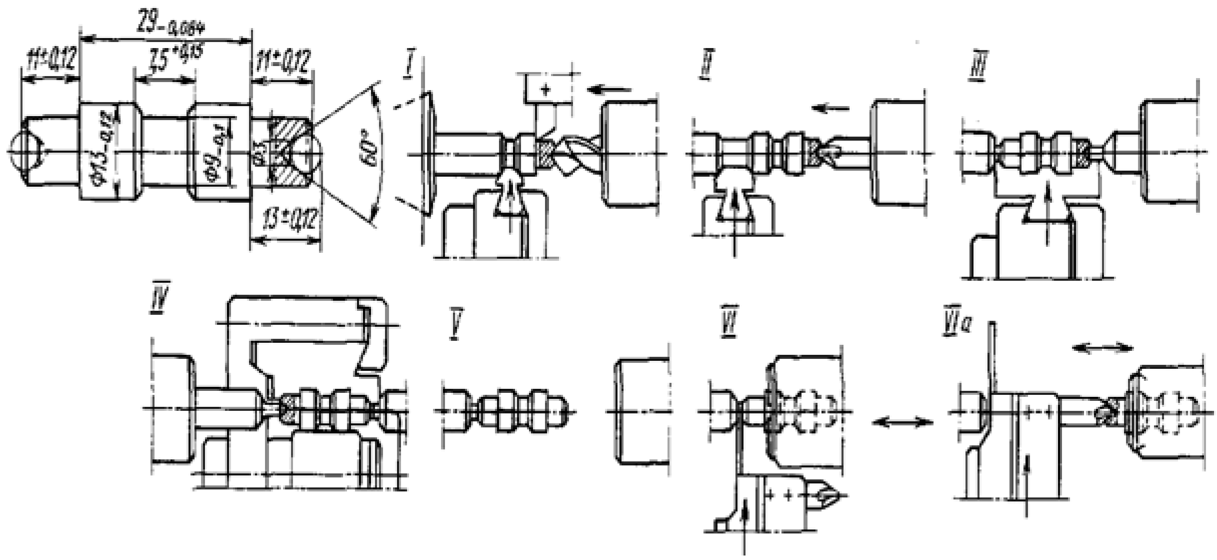


Figure 27 - Scheme of machining roller on a six-spindle turning machine

METHODS FOR FORMATION OF BASIC SURFACES OF CORRESPONDING PARTS

Machining of planes. For processing external surfaces of body parts, planing, milling, turning, grinding and stretching are used.

Planing in single and small-scale production, as well as in the processing of large, heavy parts, widely used planing. This is explained by the simplicity and cheapness of the tool and adjustments, as well as the ability to shoot large passes in one pass (up to 20 mm). The planing process is characterized by low productivity through idle strokes and relatively low velocities of reciprocating movements.

The productivity of the planing can be increased by the processing of groups of parts, which are placed in one or several rows on the table machine, the use of multiple settings (Figures 28 and 29).

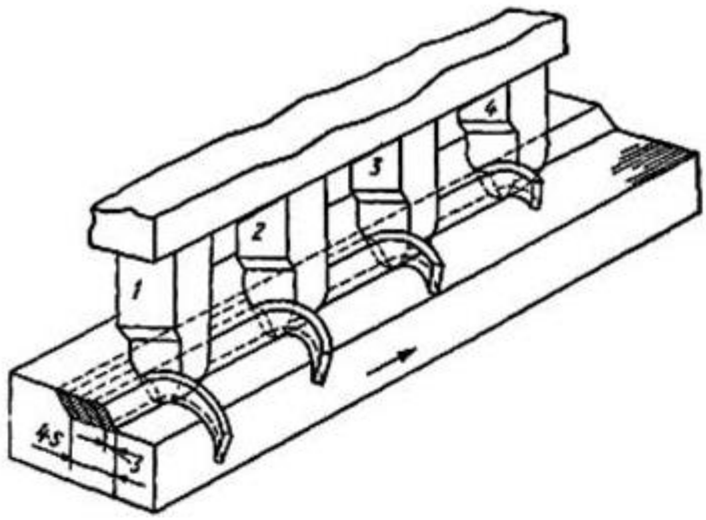


Figure 28- Many cutter mandrel (I-cut width with one cutter)

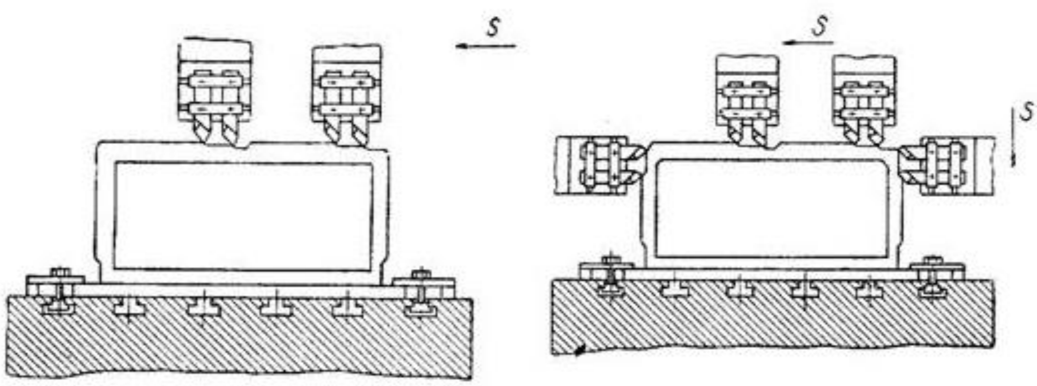


Figure 29 - Scheme of multi-planing; a-horizontal surface; b-horizontal and vertical surfaces

Milling The largest distribution in the processing of plane parts of body parts has received the method of milling. Cutting tool with this method of processing is a milling cutter (Fig. 30).

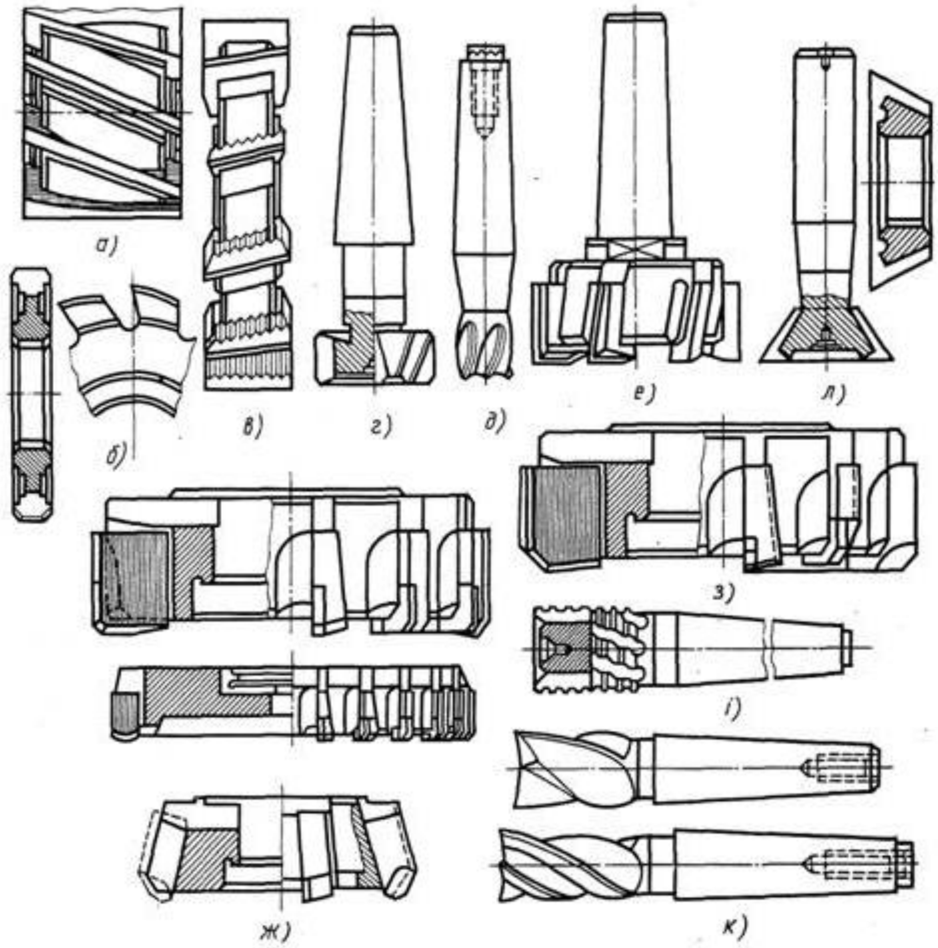


Figure 30 - Basic types of mills: a-cylindrical; b-disc; in, Mr. T-shaped; d-finite; e-face with a shaft; z-end face; from-faces step-by-step; and-finely rusty; to-key; L-corner

In the counter method of milling, the rotation of the milling cutter is directed against the feed, and in the associated method, the direction of rotation of the cutter coincides with the direction of feed.

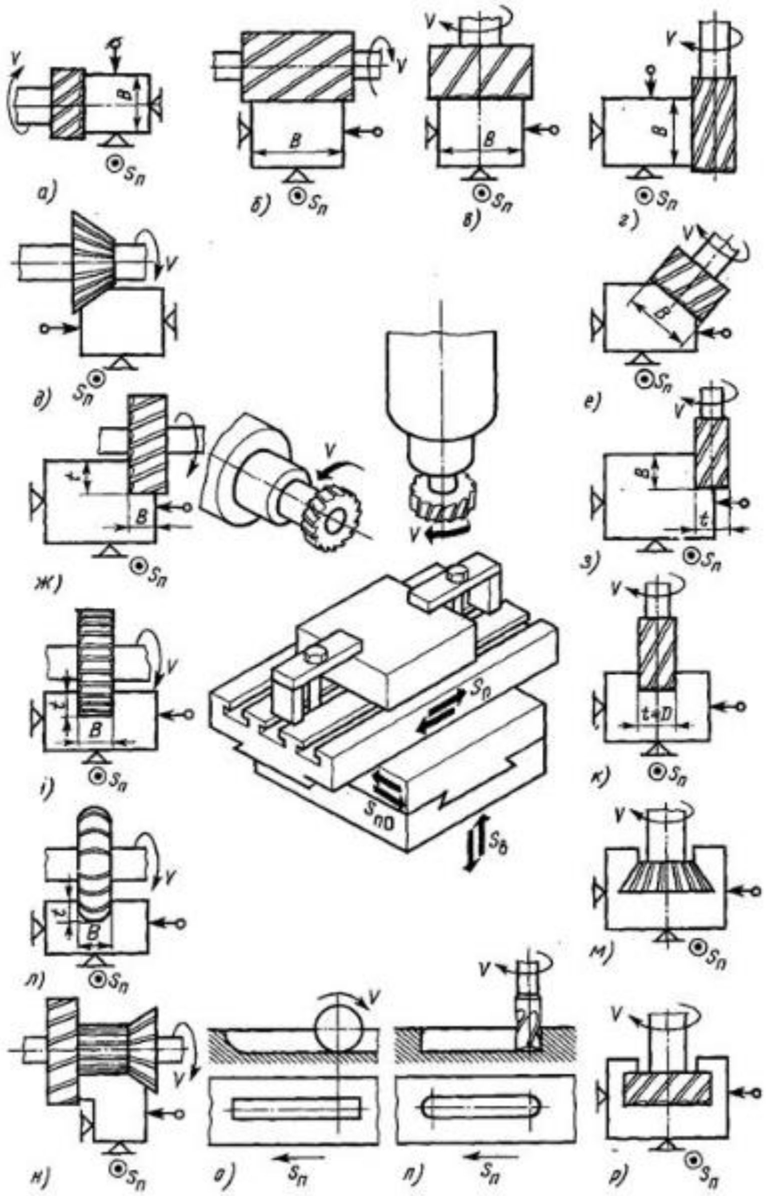


Figure 31 - Schemes of motion of cutters and workpieces during milling; Sп - longitudinal feed; Spo - crossed feed; Sв - vertical feed.

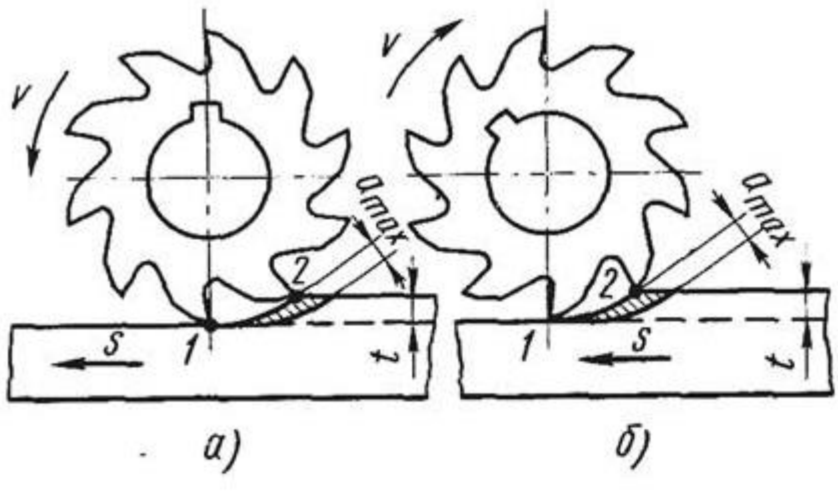


Figure 32 - Schemes of counter (a) and associated (b) milling

When counter-milling, the thickness of the cutting layer gradually increases from zero (at the entrance of the tooth to the material of the workpiece) to the maximum value. In the process of cutting the load on the tooth cutters grow smoothly and gradually.

With the associated milling at the time of tooth entry, the load dramatically increases, there is a shock phenomenon. Therefore, the associated milling can be carried out on machines that have sufficient rigidity and vibration resistance and, mainly, in the absence of a gap in the combination of the running screw-nut longitudinal table feeding, and the design of the mill should withstand shock loads. However, this method is more productive and provides a higher quality of the treated surface.

When processing billets with a rough surface (on the crust), the associated milling should not be used, because when you cut the tooth cutters in a hard crust is premature wear and failure of the cutters. When milling billets with pre-treated surfaces, the subsequent milling is better than the counter, which is explained by the following. When the milling is done, the workpiece is pressed to the table, and the table to the guides, which increases the rigidity of the tool and the quality of the surface to be treated. When counter-milling milling mills tend to tear off the workpiece from the surface of the table. Both during and after the counter milling, you can work on the table in both directions, which allows you to perform rough and clean milling in one operation.

Depending on the type of production, the nature and location of the machined surfaces, universal horizontal and vertical milling machines, console milling, longitudinal milling with 1-8 and more spindles, rotary-milling, drum and milling machines are used.

When selecting the machine for the appropriate operation, one should proceed from the fact that it could handle all the outer parts of the part with a minimum number of reinstalls.

For machining small parts in single and serial production, cantilever-milling machines with turntable tables can be used, with one unit four flat parts can be processed.

In some cases, the outer surfaces of body parts (for example, carriages, slides, tables, sliders) in large-scale production is appropriate to mill with a set of milling cutters.

In large-scale and mass production, a high-performance processing method has been used - continuous milling. It is carried out on rotary-milling, or drum-milling machines, and also possible on a non-console-milling machine (for example, type 656P) with a turntable.

Two-or three-spindle rotary-milling machines are used to handle small body parts. The table is set in a circle of restoration, the number of them depends on the size of the table, the configuration and the size of the table, configuration and size of the workpiece. In each sanction, a workpiece is installed. Milling is carried out with continuous rotation of the table. In this case, parallel-sequential draft and finishing are carried out.

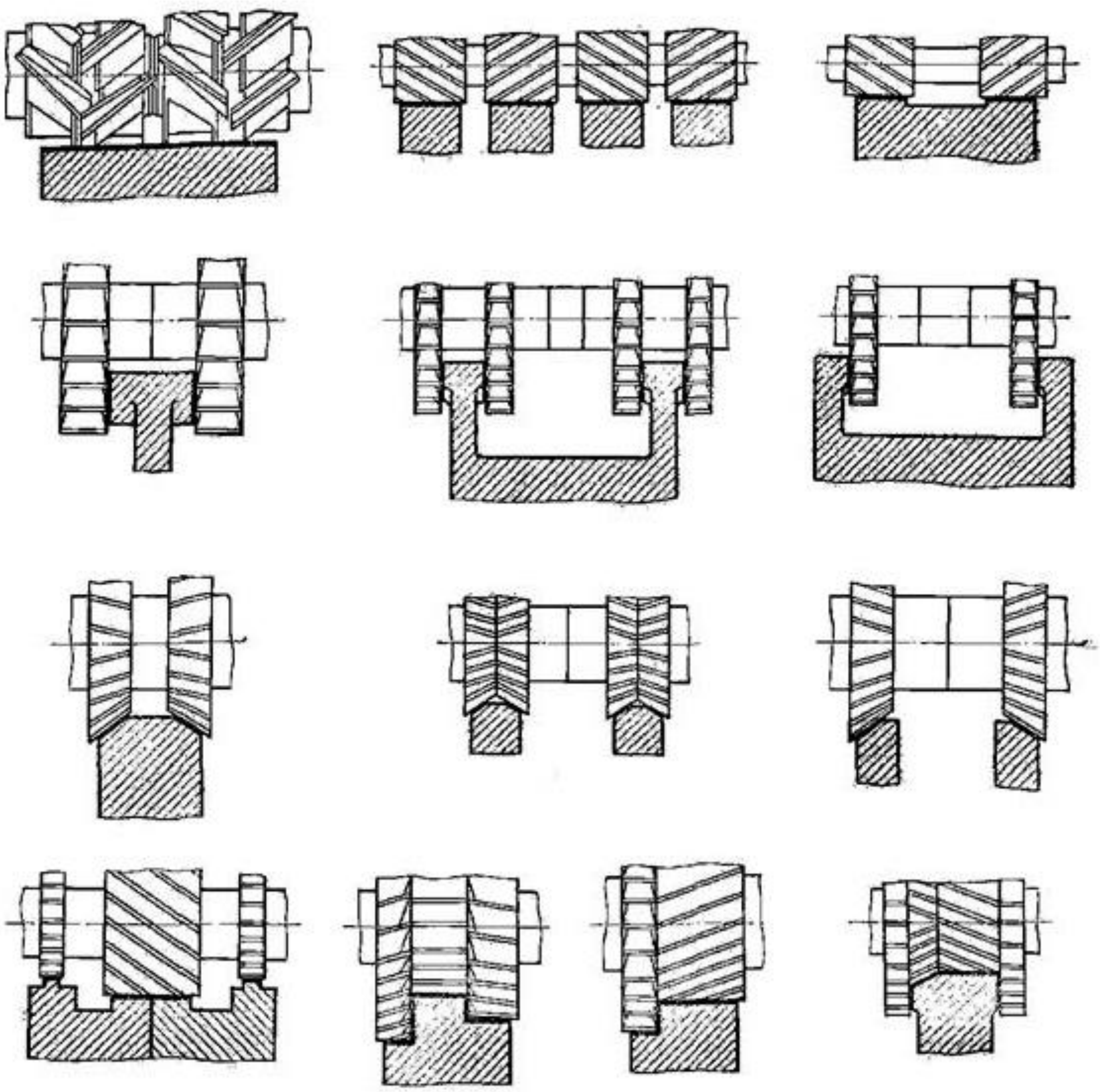


Figure 33 - Schemes of processing with sets of cutters

Since the workpiece change takes place outside the milling area when the table is rotated, the auxiliary time completely overlaps with machine time.

On the drum and milling machine milling with end mills with continuous rotation of the drum relative to the horizontal axis. The change of blanks is carried out with continuous drum rotation.

Since the tables of rotary-milling and drum-milling machines rotate slowly, applying the flow of feed, to ensure continuity of the milling, the machining surfaces should be placed close to each other. In this case, the processing will be more economical.

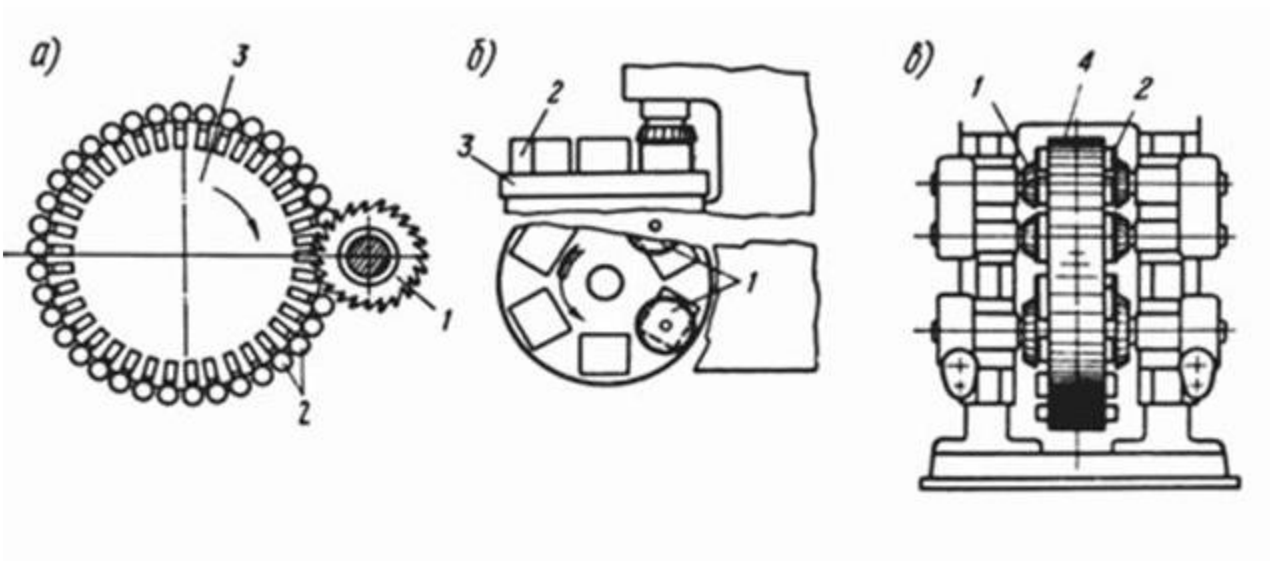


Figure 34 - Placement of billets for processing on round-the-clock and drum-milling machines: a-round-rolled milling machine with one spindle; b-rotary-milling machine with two spindles; in-drum and milling machine; 1-cutters; 2-workpieces; 3-table; 4-drum

Flat-grinding machines have a rectangular or round table,and the machines with a round table are more productive. On them, in the case of small allowances, it is possible to perform continuous grinding.

Advantages of flat grinding are especially noticeable in the processing of continuous surfaces of a complex profile. Milling and planing of such surfaces are carried out in lowered modes, as a tooth cutter or cutter crosses a foundry crust, which reduces the stability of the tool. In addition, in cast iron parts of the metal extinction on the output edges, vibrations of the machine appear. When grinding such phenomena does not occur. When designing technological processes it is necessary to take into account the advantages of grinding.

Extension in mass production, widespread use has been stretched outward planes. Prolongation The most productive method of treatment processing is performed on special high-speed and high-speed long machines. The treatment is carried out by the drafts of solid alloys with a cutting speed of up to 60 m / min. (for cast iron parts).

Advantages of dragging before milling are high performance and high precision machining.

Disadvantages of dragging - high cost of drafts, high forces that arise during dragging, which do not allow to handle details of low rigidity. Exterior drag can be used for rough and finishing.

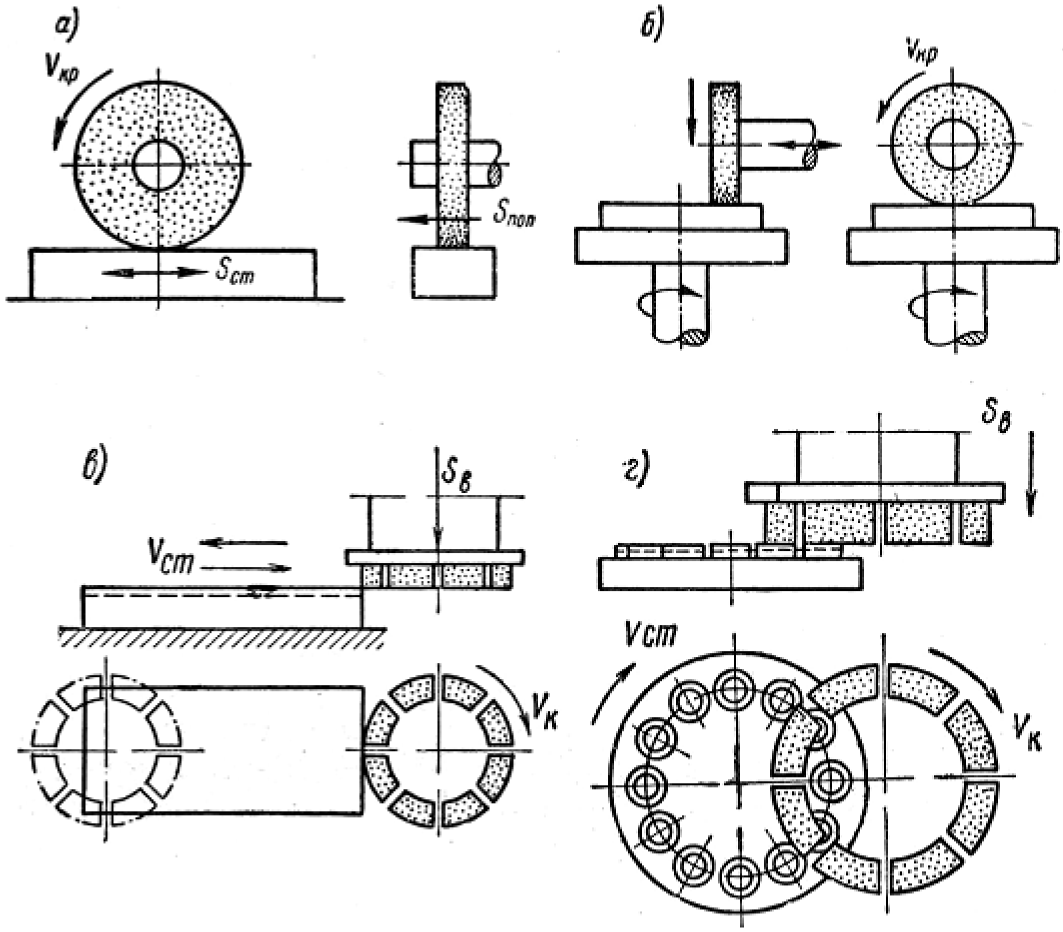


Figure 35 -Typical grinding schemes of planes: a-periphery of the circle with the reciprocating motion of the table; b-periphery of a circle on a rotating table; in-the-end of the circle with the reciprocating motion of the table; g-end of a circle on a rotating table

Hole processing. The treatment of the main openings is the most responsible and labor-intensive part of the technological process of manufacturing body parts.

Treatment of openings is divided into roots, finishing and finishing.

For rough processing, high-performance equipment and tools are used.

Pure finishing should ensure the accuracy of the dimensions, geometric shape and relative position of the working hole. For finishing the tool requires a high stability, which provides high accuracy and cleanliness of the surface, as well as fairly rigid equipment.

In some cases, they plan to heap the holes with the help of chisels, cutters or rough scans.

Finishing treatment is used in case of necessity to increase the accuracy and purity of treatment.

For the treatment of openings, use drills, cutters, cutters, screws, blade heads, boring plates.

Exhaust treatment of openings is also carried out by plastic deformation. The influence of hole treatment methods on precise and qualitative indices of the treated surface is given in tables 2, 3, 4 and 5.

Drills are used as a preliminary tool for drilling holes in solid material. Holes of large diameters (30 mm and more) are drilled in two or three transitions.

The drill accuracy on the conductor is 12-13 grades.

The holes are obtained in the casting of single and small-scale production, are cut with cutters.

Counterboring toolr is used for roasting of molten holes, as well as for semi-pre-boring holes after drilling or cutting.

The main method of finishing the holes of 6-8 qualities with a diameter of up to 400 mm is deployment.

Accepts for rough deployment under normal operating conditions reach 1 mm on diameter. Under the clean upgrade, the tolerances fluctuate within 0,02-0,3 mm.

For obtaining holes of 8-10 qualities of precision, one-time deployment is used. For obtaining openings 7-8 qualifications of accuracy - double. Under the final deployment leave a tolerance of 0.05 mm or less.

The rods in the processing process perceive large radial and minor axial loads. In this regard, scans do not provide the accuracy of the direction of the axis of the hole. This is achieved by a boring cutter or other tools (cutter or crochet head, counterboring tool) with forced centering and reliable direction.

The disadvantage of overturning during the deployment of precise openings with a horizontally located axis is the appearance of an ellipse of the opening. Therefore, in case of a deployment, it is more expedient to place the vertical axis of the working hole. Screws, as a rule, do not apply for the deployment of large, short, deaf and with intermittent surfaces of openings.

Combined cutting tools are used to improve the processing efficiency, which allow to perform consistently in one pass of the rough and finishing surface treatment or to combine several types of machining (for example: drilling, sewing, turning, cutting the ends), or processing several surfaces.

The main openings are routed on radial-drilling, horizontally-boring, coordinate-boring, round-robin and aggregate machines, and in some cases also on lathe machines.

There are three main methods of boring holes on horizontal boring machines: console mandrels; boring bar using the support of the rear rack; in conductors with a hinged connection of the metering bellows with the spindle of the machine. Feeding with each of these methods is carried out by a spindle or a table. When boring with a cantilever mandrel, in comparison with boring bars, it is facilitated by the installation of a cutting tool, the installation and checking of the cantilever itself mandrels and measurement of the workpiece, which leads to a reduction of auxiliary time.

Console mandrels are sharpened at the general outlet of the tool (length of the mandrel from the end of the spindle and the length of the retractable part of the spindle), equal to (5-6) D, where D is the diameter of the mandrel. The mandrels should be short and rigid. When a large outflow is possible, the "sagging" of the tool and the spindle. All this leads to errors in the shape and size of the boring hole. Therefore, this method should be used for boring short holes, using rigid braces and a minor overall release of the tool.

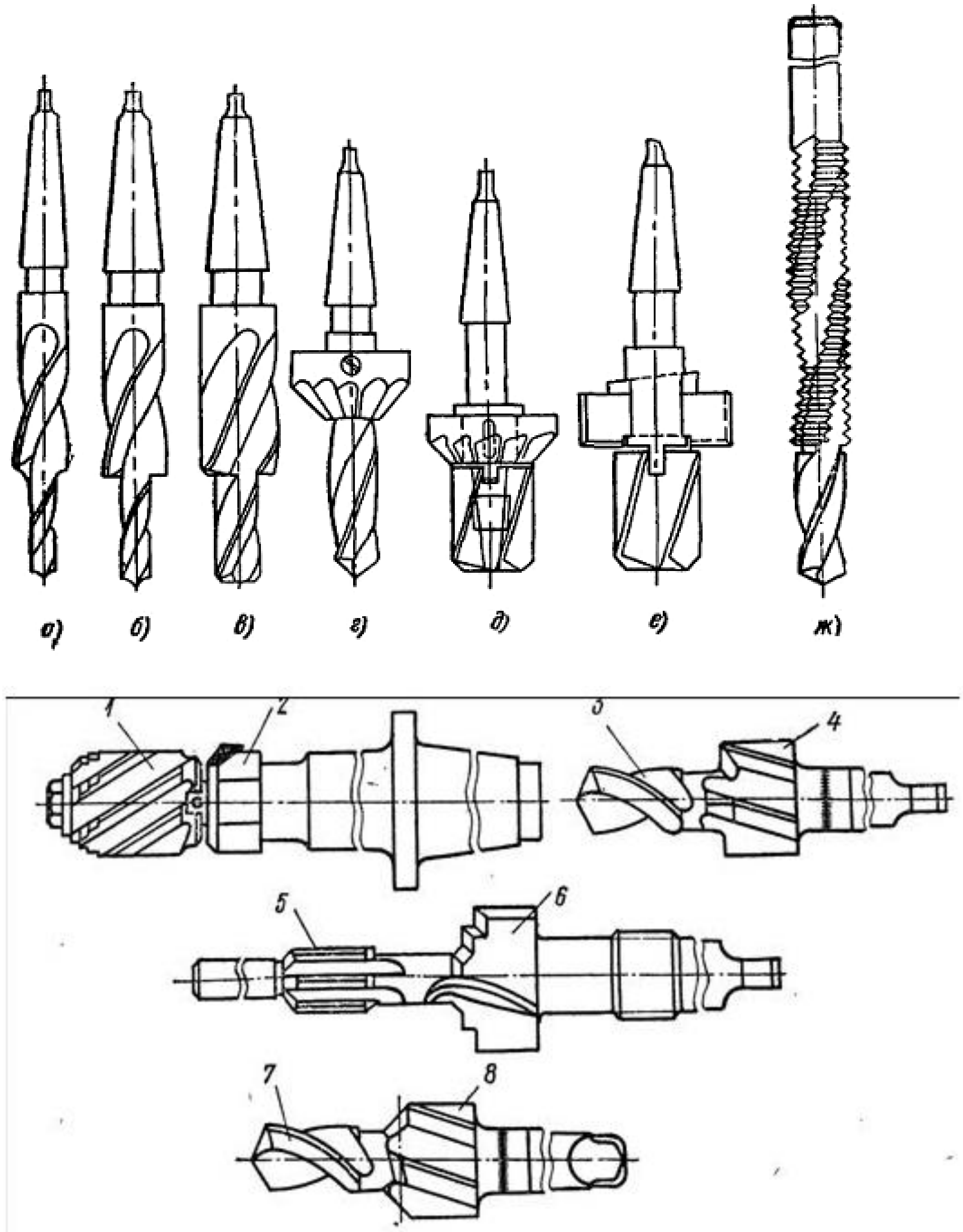


Figure 36 - Special combined tool

Boring with a cantilever with a table feeding is carried out with the permanent removal of the tool. In this case, the errors of boring will be less.

Boring of body parts can be performed in the same position if the housing has openings located in one outer wall, or when the coaxial holes are located in closely spaced opposite walls and have decreasing diameters. In this case, you can rotate the highest accuracy of the direction of the axes of the holes.

In other cases, the boring of the coaxial holes can be performed in two positions with one installation of parts with a table rotation of 180 ° C. When boring body parts for two establishments there are installation errors and significantly increases the auxiliary time, since after turning the table it is necessary to find the position of the axis of the spindle, coinciding with the previously rutted hole. This method is used only when processing large parts.

It is recommended to replace the boring with one cutter with a double-cut boring and a multi-cut tool. Before using a multi-blade tool to handle openings that have unprocessed ends, at the inlet and outlet it is necessary to remove the chamfers to remove the foundry crust.

Boring using the support of the back wall are used in the processing of large heavy parts, which have openings in the opposite walls, or when processing holes that have a length significantly greater than their diameter. In this case, the support of the back wall and the spindle must be coaxial.

In serial production is widely used for boring in special treatments - conductors. The conductors can have a one-way front or rear direction for the tool or mandrel, as well as forward and rear direction on one axle or double forward direction.

In the first case, the guide resting element does not provide a sufficiently reliable direction of the tool, so the tool or mandrel should be tightly connected to the spindle. In this case, it is necessary to provide the exact relative position of the guide element and the spindle with the help of a centrifuge or special trap.

The reclamation, which has a double direction of the tool, provides a reliable determination of the relative position of the tool, so the tool or mandrel connect the spindle. When boring in conductors with a hinged connection of spokes with spindle, the geometric errors of the machine tools practically do not affect the accuracy of machining.

Manufacturing of responsible openings in small body parts can be performed on radial-drilling machines. To do this, there should be a reliable direction of the tool, which is achieved using the use of adjustments with guiding elements and punctures.

Boring on radial drilling machines provides high precision machining. Accuracy of openings corresponds to 7-8 qualifiers; parasiticity of the parietal mass, nonperpendicularity, inequality and deviation of the interaxial distances - within ± 0.02-0.03 mm; performance is higher than when machined on horizontally boring machines.

The widespread distribution in serial production has the processing of body parts on coordinate boring machines. It obtains high accuracy of sizes and their relative position.

In large-scale and mass production for processing holes in body parts widely used aggregate boring machines. On aggregate boring machines perform different processing transitions openings: drilling of shallow and deep openings, cutting, boring and deploying of cylindrical and conic holes, trimming of ends, removal of chamfers, cutting of grooves, boring of grooves. Aggregate boring machines can be one-sided, multilateral, one-position and multi-position. By the way they work, they can be sequential, parallel or sequentially-parallel. Their power heads can be moved vertically or at an angle. The various combinations of these features lead to a large number of possible layouts of aggregate boring machines.

Fixing and other holes treatment.

All other openings (in addition to the main ones) in the body parts (fasteners, openings under the stoppers, oil channels, oil masks) have a small diameter. They are processed on the drilling machines, performing transitions - drilling, winding, crochet, chamfering, turning, cutting.

Wide application for the manufacture of such openings have been made conductors. Depending on the size and design details of the parts and the seriality of production, different types of conductors (box-type, overhead and rotary) are used, or they work on marking. To improve accuracy and improve working conditions, drilling should be done in two or three transitions: firstly, at the specified hole centers, drill a hole with a small diameter drill (approximately equal to 0.25 D, where D is the diameter of the hole), then drill a drill diameter D, if D 25 - 30 mm. At a large diameter of the hole, drilling and drilling or cutting are carried out. Cutting the ends of the ends is made with cutters or cutter cutters. In the openings under the thread to the cutting of the threaded conical grooves or a cutter removed on the incoming side of the chamfer to the outer diameter of the thread.

Parts weighing up to 30 kg. can be processed on vertical drilling machines. Parts of large weight are processed on radial-drilling or horizontally-boring machines.

When machining parts on drilling machines, when it is necessary to use a large number of different instruments, short-range cartridges and drill revolving heads are used to reduce the auxiliary time for tool installation. In large-scale and mass production, openings are machined on aggregate multi-spindle drilling machines.

Final processing of the main openings. Final processing of the main openings includes subtle boring, planetary grinding, honing, rolling rollers.

Thin (diamond) boring is used to obtain high accuracy of dimensions, geometric shape, direction and straightness of the axis of the hole. Characteristic for such boring is the work with high speed of cutting, small feed and depth. The speed of cutting during the treatment of iron is assigned in the range of 100-200 m / min., Steel - 120-125 m / min., Feed rate at the processing of pig iron - 0,03-0,15 mm / rev; steel - 0,02-0,12 mm / rev. The cutting depth is 0.1-0.35 and 0.1-0.3 mm, respectively.

Machines for such boring - single-spindle and multi-spindle, vertical and horizontal - have high stiffness and vibration resistance.

Cutting tools are single-headed cutters with solid alloy plates. For boring of parts from colored alloys also use diamond cutters.

Grinding. Internal grinding is used mainly in the processing of precise openings in hardened parts, as well as in cases when it is impossible to apply more productive methods of precise treatment of openings. There are two main types of internal grinding: grinding the hole in the preform, rotating and polishing the hole in a fixedly-mounted preform.

The first method is used when grinding openings in small-sized billets representing the body of rotation. The second method is used when grinding openings in billets, which do not belong to the bodies of rotation (for example, case details of box-type).

In the first case, the workpiece is pressed in the cartridge and brought to the rotary movement.

The grinding wheel rotates in the opposite direction at a high speed, carries forward motion (longitudinal feed) and intersects (cross-flow). In the second, the workpiece does not rotate, but is installed on the table of the machine, and the spindle of the grinding wheel, in addition to the rotary motion, carries out a planetary motion on the inner surface of the part, at a speed corresponding to the speed of rotation of the workpiece when grinding for the first way. In both cases, the longitudinal feed of the grinding wheel along the axis of the grinding hole is carried out: in the first case, the spindle head movement, in the second - the movement of the table.

Planetary grinding is used mainly for the processing of large and heavy parts of complex shape, which fixing in rotating spindles is difficult or virtually impossible. Inner planetary grinding is used for processing holes with a diameter of more than 150 mm. In this case, the workpiece is installed on the table machine. Planetary interior lathes are horizontal and vertical.

The grinding wheel, rotating in relation to the axis of the spindle, carries out a planetary motion, that is, the rotation relative to the axis of the grinding hole.

Planetary motion of a circle around its axis is carried out at a speed of 25-50 m / s and around the axis of the workpiece at a speed of 40-60 m / min. Longitudinal flow is carried out by a reciprocating movement of the workpiece, transversal - by moving the grinding wheel. Planetary grinding is used in single and serial production.

The disadvantage of this method is low productivity.

The most significant difference between the internal grinding from the outer is that the processing is carried out around a small diameter. Usually, the diameter of the circle with internal grinding is 0.7-0.9 in diameter of the grinding hole. The circumferential velocity of the wheel ranges from 10 m / s to 30 m / s, and the part rotates at a speed of 1-50 m / min.

Inner lathes are less productive than round-grinding for external grinding, and have less technological capabilities. Abrasive circle of small diameter wears out quickly, it requires frequent editing and replacement. The spindle of the machine has a significant departure, and due to this low rigidity. However, for details with hardness HRC 40 and more that do not allow blade processing, grinding is the only method that allows not only to improve the accuracy of the aperture itself, but also the accuracy of the coordinates of its axis. Possible grinding through, deaf, conical and shaped surfaces.

Open cylindrical and conic holes of considerable length are polished by the method of longitudinal feed (on the passage), and short - by the method of cutting. On

Internal grinding has its technological features. The diameter of the abrasive wheel is chosen by the largest, which is allowed by the diameter of the working hole Dkr = (0,8-0,9) Dotv. The height (width) of the circle is taken depending on the length of the working hole (Lkr = 0,8 Ldet.).

Pure grinding provides precision of the sizes of openings IT6-IT7; roughness of the surface Ra = 0.8 ... 3.2 microns. In the long run it reaches Ra = 0.4 microns. For internal grinding, the following cutting modes are recommended: - for cast iron - Vkr = 20-30 m / s - for steel - Vkr = 30-45m / s; - Vzag = (0,015-0,03) Vkr; - Spots = (0,2-0,3) B - clean grinding; - Bottom = (0,6-0,8) B - rough grinding (Fig. 30).

The allowance for grinding holes depends on the diameter of the hole and its length and are recommended 0,07-0,25 mm for diameters up to 30 mm and 0,18-0,75 mm for diameters up to 250 mm.

The most common method is grinding on the aisle with a longitudinal flow of feed. This grinding ensures the accuracy of the dimensions, shape and, if appropriate, the accuracy of the mutual arrangement of the treated surfaces.

For grinding the end of the part after polishing the hole in it, it is advisable to use machines that have, in addition to the circle for grinding the hole, the grinding wheel for the end. This ensures that the perpendicularity of the end face and the axis of the hole is strictly perpendicular due to processing in one installation.

Honing holes. Honing is called the method of finishing the surfaces of fine-grained abrasive bars with their combined relative working motion. Honing is a mechanical finishing of a sharpened, rolled or polished hole with a special rotating head (chon) with sliding abrasive bars, which, moreover, has reciprocating motion. In practice, this method is used mainly for the treatment of interior surfaces of the rotation.

Honing is used to process cylinders of automobile and tractor engines, openings in the foam of the rear wheels, holes of the hydraulic cylinders, plunger pairs, and others. It is expedient to use it in serial and mass production when processing high-precision openings having a length of greater diameter.

Honing reduces the deformation error, increases dimensional accuracy, reduces the roughness of the surface, retains the micro hardness and structure of the surface layer. However, honing can not eliminate the deviation of the position and direction of the axis of the hole.

Honing is performed on special machines, which are divided into two groups: vertical-honing and horizontally-honing.

Honing head (hon) performs combined movements: rotation and reciprocating displacement at constant pressure of abrasive bars on the surface to be treated in the environment of the lubricating and cooling liquid.

On the head fix fine-grained abrasive bars (4, 6, 8 pieces). Heads with a large number of bars are most effectively working.

The cutting process is carried out by a combination of rotary and reciprocating movements, which are usually provided to the honing head, but can be provided and the workpiece. In the first version, the workpiece is stationary, and in the second it is an instrument. Due to such a combination of movements, the trajectory of moving abrasive grains on the treated surface is a grid of screw microscopic lines - traces of moving abrasive grains. The angle θ of the intersection of these tracks depends on the ratio of velocities.

Abrasive bars always come in contact with the surface to be treated, since they can slip in the radial direction. The disassembling of bars in the radial direction is carried out by a mechanical, hydraulic or pneumatic method. Pressure of bars is regulated.

In addition to abrasive bars, brusks made of synthetic diamonds are used on a metal binder. The upper diamond-bearing layer has a thickness of 2 ... 2,5 mm. Diamond honing is achieved with the highest processing efficiency due to the high resistance of diamond bars.

In the process of honing, a smooth and shiny surface with an accuracy of 4-6 qualities is obtained and the roughness of the surface Ra = 0,32 ... 0,02 microns. The accuracy of the shape, which is achieved for holes with a diameter of 100 ... 120 mm, is 0.01-0.02 mm.

Honing head rotates at a speed of 60-75 m / min during the processing of steel blanks. The velocity of the reciprocating head movement is about 12-15 m / min. The pressure of the bars on the surface to be treated is from 0.05 to 0.20 MPa. The tolerance for processing - 0.05 ... 0.10 mm, usually removed in 1-2 minutes. As a lubricant-coolant, kerosene or light solvent is usually used.

In the process of honing abrasive bars remove a layer of metal in the thickness of 0,3 ... 0,5 microns in one double working stroke with a total drop of 0,01-0,07 mm for steel and 0,02-0,20 mm for cast iron. This removes both the microns remaining after the previous operation, as well as some part of the base metal, which eliminates cone-shaped, oval and barrel-like.

Honing practically displaces the processing of openings by rubbing, since gluing is an unproductive process.

The complex movement of the bars provides a large area of contact (the number of grains of abrasive, which simultaneously participate in the cutting, 500-1000 times more than when grinding), which provides high productivity of the process, and low pressure of bars (6-10 times less than when grinding) allows you to cut very thin layers (up to 0,005 mm) and ensure high surface cleanliness The usual length of honing is 1-5 minutes.

Hinging holes in length, less than half the diameter of the working hole is difficult, since the head is badly self-aligned through the hole. In connection with this, they are used instead of a hinged, rigid head mount, and self-fixing provides fastening of parts on the table, which "floats" in radial directions.

The allowance for honing depends on the diameter of the hole, the material of the part and the nature of the pre-treatment. After boring, the allowance for honing should be within 0,05-0,08 mm per diameter, after rotation - 0,02-0,04 mm and after grinding - 0,01-0,02 mm. Honing is advisable to use in the processing of high-precision holes, having a length of greater diameter, in mass production and mass production.

Control of body parts. Means of measuring the diameter of the holes are used depending on the specific production conditions. Used as universal measuring instruments, as well as various caliber-plugs. The universal measuring instruments are indicative intrinsic measurements, micrometer, specialized calipers. For measuring holes with a diameter of up to 500 mm, tight boundary gauges are widely used. For holes with a diameter of more than 500 mm, the main means of measurement are micrometric and indicator of different types.

To ensure proper control, it is necessary to choose the means and method of control correctly. It requires that the measuring instruments meet the requirements of the accuracy of the workpieces. Based on the experience of industry, it can be assumed that the margin of error of the measuring instrument should be 10-20% of the tolerance of the measured value, in some cases, when the tolerance is too small, the marginal error may be up to 30% of the tolerance.

In particularly critical cases, it is necessary to establish a production (technological) tolerance, equal to the size tolerance, and reduced by a doubling of the marginal error of the measurement method.

In most cases, it can be assumed that the output size beyond the tolerance field associated with the error in the measurement method is insignificant compared to the tolerance field and can not significantly affect the performance properties of the parts. Therefore, all measurements are carried out at a constant standard tolerance to the size.

When choosing measuring instruments you must also take into account economic indicators: their cost, the time it takes to adjust, the time required to measure, reliability and stability of work, the duration of work before repair.

The simple and reliable means of controlling the holes are the limit gauges. For the possibility of checking the shape errors, they should be made with a full passage and incomplete passage sides.

Automobile plants are widely used pneumatic control methods, which allow to perform contactless measurements with large transmission ratios and to count micron fractions. Pneumatic control methods can be used to measure diametrical sizes from 5-6 mm and up with an accuracy of 0,001 mm, errors in the shape of openings, in hard-to-reach places, at many parameters at the same time. Pneumatic methods allow relatively easy and reliable automation of control, so they should be considered progressive.

Errors in the shape of holes in the cross-section (ellipse, cut-off) are determined by measurements in different radial directions. The errors of the shape in the longitudinal section (taper, barrel-shaped) are determined by the results of measurements in various cross-sections. To measure the depth of the holes using templates, calibers.

To control the accuracy of the relative position of the holes, the control mandrels are preferably used. They are made of steel and tempered (hardness HPC 48-52); The external cylindrical surface is performed on 5-6 qualities, surface cleanliness - Ra = 0.8 ... 0.1 µm. When controlling small openings (diameter up to 50 mm), the mandrels are installed directly into the openings, and at large diameters of the openings - through the control sleeves. To avoid a large number of control frames, for holes with a diameter of more than 50 mm the mandrels will produce three sizes at 30, 50 and 80 mm in diameter. For holes with a diameter of up to 120 mm steel hardened bushings are used, and for openings of greater diameter - cast-iron bushings with grooves or holes in the walls to reduce weight. The outer surface of the sleeve has a deflection, slip or dense landing of 5-6 qualities of accuracy. The control mandrels in the holes of the sleeves are set by the landing of slip 5 qualities of accuracy. The length of the coupling of the mandrel to the sleeve must be at least 1.5-2 its diameter. Principal schemes of measurement according to the basic parameters of the accuracy of the relative position of the holes are shown.

The parallelism of the holes is usually checked by the control, if the part and mandrel are sufficiently rigid, indicating devices. Optical, pneumatic and other control methods can also be used to check the coaxiality of the openings.

The checking of the mandrels, however, does not reveal the appearance of non-uniformity (parallel displacement, relative rotation, or crossing of the axes in space) and the magnitude of the error.

When testing the inconsistency of indicator devices, determine the radial beats, equal to doubly incommensurable. If the axis of the openings is not parallel, the test must be carried out in different cross sections, as in the case of a one-time check, when the point of intersection of the axes will be in the plane of rotation of the indicator, the error may not be detected.

To ensure the high quality of the part, it is necessary that the maximum non-uniformity (maximum distance between the axes of the holes within the overall dimensions of the part) is within the tolerance. Maximum inequality can be determined by calculation, knowing the incomparability in separate sections, the size of the part and the location of the axes. Insecurity in measuring in two transverse sections at a given distance from each other should not exceed the tolerance. The distance h from the axis of the hole to the base plane is determined on the control plate by measuring the dimensions h1 and h2 by means of a block of finite measurements, or measuring the dimensions from the upper creature mandrel to the plane of the plate using a shaft seal, a shunting gens or a gauge device. In this case, the parallelism of the axis of the opening with respect to the plane of the base is also detected.

The distance from the axis of the holes to the vertical plane is determined similarly, using a corner. The non-parallelism of the axis of the hole with the plane of the substrate is determined by the indicator.

The non-perpendicularity of the end plane relative to the axis of the openings can be verified using the indicator device or a special caliber. In the first case, the non-perpendicularity of the end face on the diameter D is determined as the difference between the indicators of the indicator when rotated relative to the axis of the apertures. In the second case, check "paint" or measure the gaps in two opposite points along the periphery of the disk.

The positions (parallel) of the axes of the holes in one plane are checked using the ruler and level. In positions l-l and ll-ll or a special stylus and level, or a special device, depending on the location of the axis plane. The positions of perpendicular axes of holes in one plane are checked by special calibres.

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