THE STUDY OF THE GEOMETRY OF THE WORKING PART OF THE TURNING CUTTERS

Purpose of work: consolidation of theoretical knowledge about the purpose, application and design of general purpose turning tools; familiarization with methods and means of measuring their geometric parameters.

Brief Theoretical Information

1. *General provisions*. General-purpose cutters are designed for machining flat, cylindrical, conical, end surfaces, as well as for grooving and cutting pieces. To obtain surfaces of complex profile, special cutters are used - shaped.

2. *The main types of cutters*. Cutters used in mechanical engineering can be classified according to the following criteria:

a) by type of machines (Fig. 1): turning, planing, chiselling;

b) by type of processing (Fig. 2): continuous, persistent, cutting, slotted, detachable, dowel, boring, threaded, shaped, for finishing and roughing (peeling) processing;

c) by shape of the working part (Fig. 3): straight, bent, curved, drawn;

d) by direction of feed: right, left;

e) by the method of fastening the cutting part (Fig. 4): solid, composite, prefabricated: with a soldered or glued plate, with mechanical fastening of polyhedral plates;

f) by the nature of the tool material of the cutting part: high-speed steel, hard alloy, mineral ceramics, superhard synthetic materials;

g) by shape of the front surface (Fig. 5): flat, flat with a chamfer, curved;

h) by section of the fastening part (holder): rectangular, square, round.

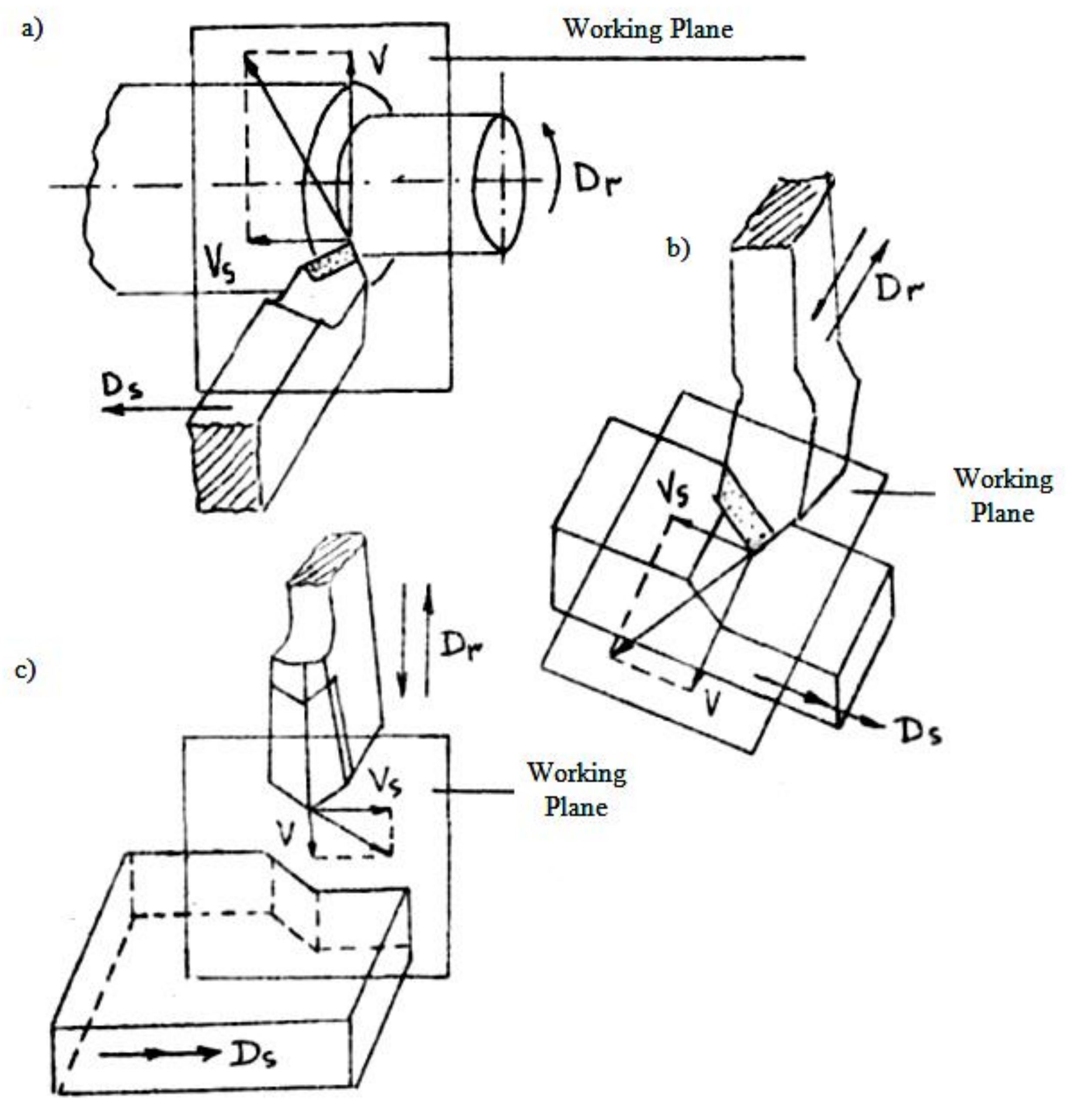

Fig. 1. Kinematic Elements of Cutting with a) Turning, b) Planing, c) Chiselling

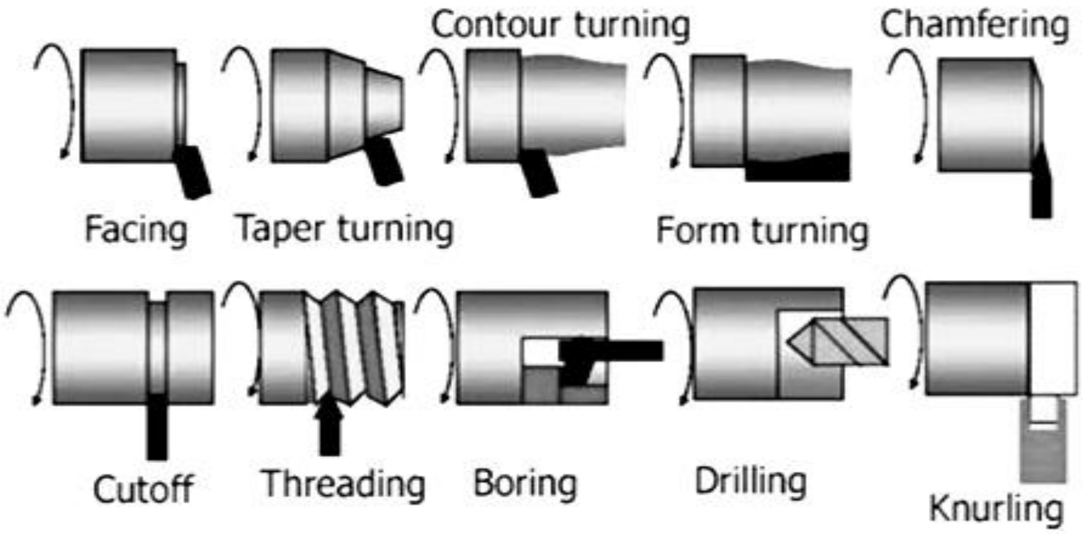

Fig. 2. Types of Cutters by Type of Processing

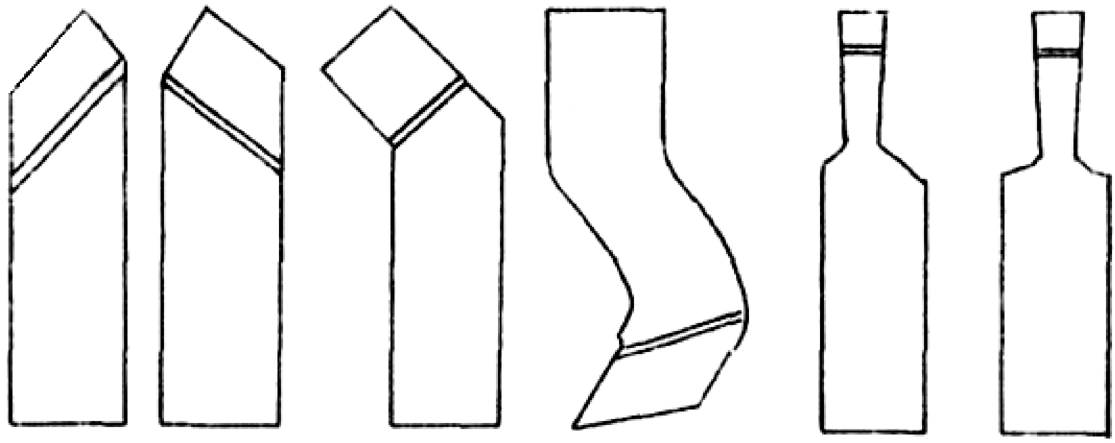

Fig. 3. Types of Cutters According to the Shape of the Working Part

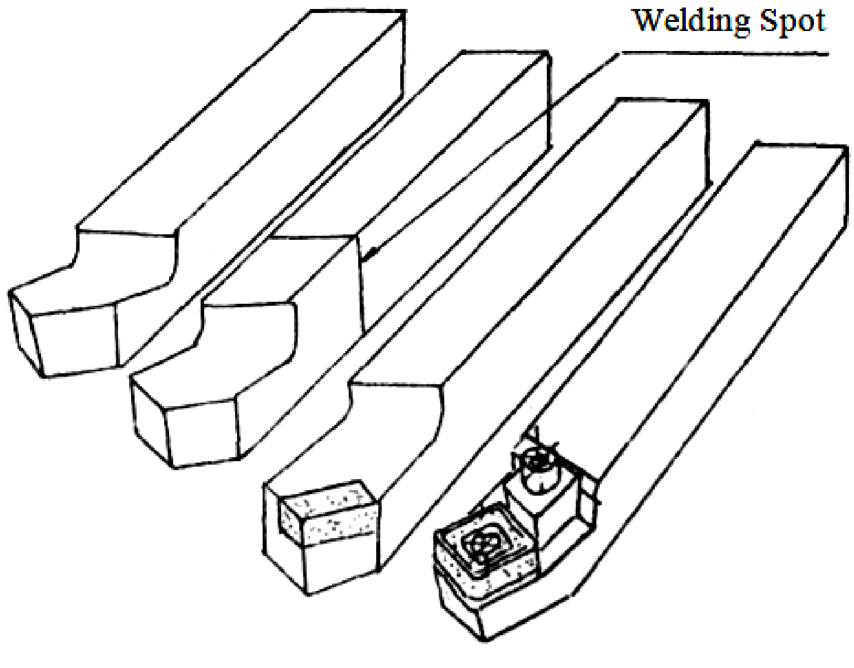

Fig. 4. Methods of Fastening the Cutting Part

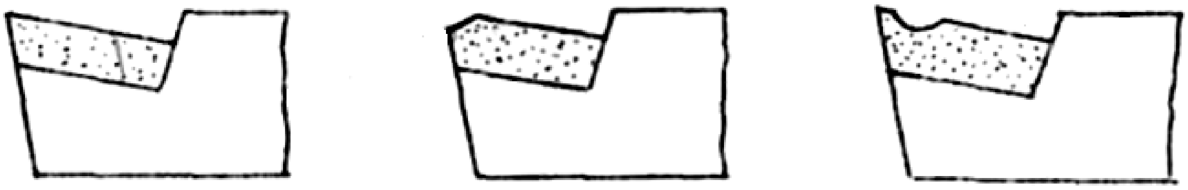

Fig. 5. The Shape of the Front Surface

2. Design and geometric parameters of the cutters. The cutter (Fig. 6) consists of the working (head) and fixing (holder) parts. The cutting part of the cutter (Fig. 6) is limited by the front and rear (main and auxiliary) surfaces, which, when crossed, form the tool blades – wedge-shaped elements used to penetrate into the workpiece and separate the material layer.

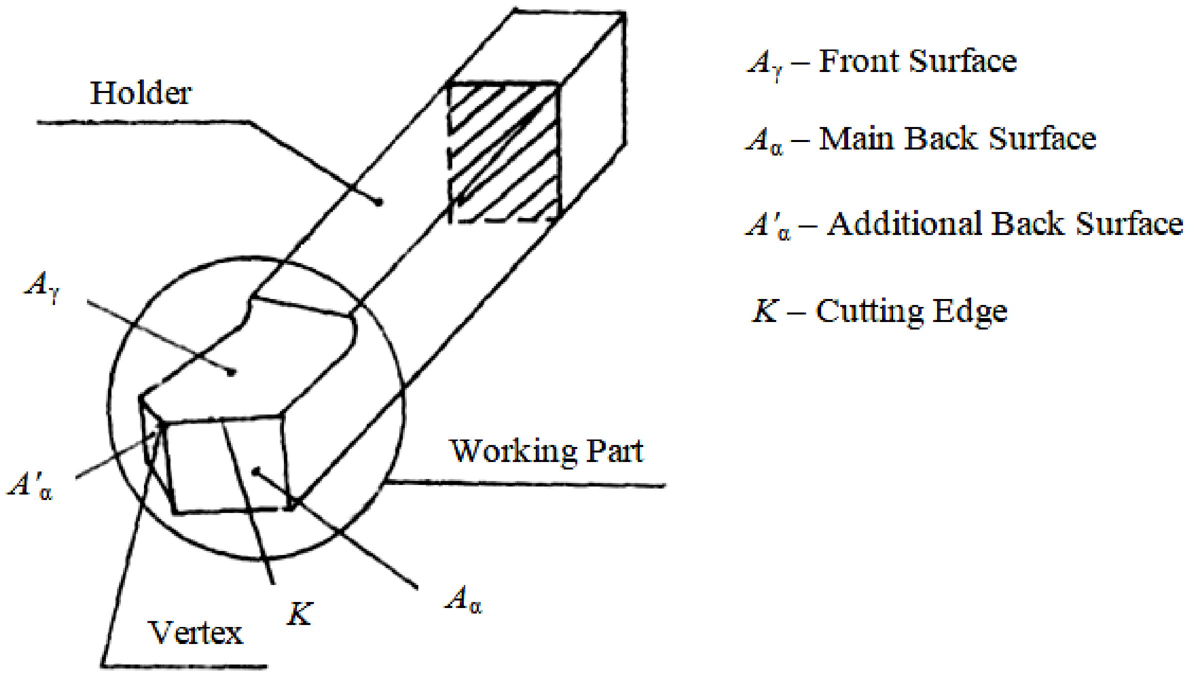

Fig. 6. Elements of the Blade of the Turning Tool

The front surface of the blade A_γ – the surface of the tool in contact with the cutting layer and chips during the cutting process.

The rear surface of the blade A_α – the surface of the tool in contact with the workpiece surfaces during cutting.

The cutting edge K – the edge of the tool blade, formed by the intersection of the front and rear surfaces of the blade.

The blade vertex – a section of the cutting edge at the intersection of two rear surfaces.

Main cutting edge K – the part of the cutting edge forming the larger side of the cross section of the cut layer.

Auxiliary cutting edge K_1 – the part of the cutting edge forming the smaller side of the cross section of the cut layer.

Main back surface A_α – back surface of the tool blade adjacent to the main cutting edge.

Auxiliary back surface A'_α – the back surface of the tool blade adjacent to the auxiliary cutting edge.

The location of these surfaces and cutting edges in space is characterized by a number of angles called cutter angles. To determine the geometric parameters of the tool blades, the following coordinate plane systems are adopted: instrumental, static, and kinematic.

Instrumental coordinate system – a rectangular coordinate system with a beginning at the top of the blade, oriented relative to the geometric elements of the cutting tool, taken as the base (for turning cutters - the reference and side planes). It is used for the manufacture and control of tools.

Static coordinate system – a rectangular coordinate system with a beginning at the considered point of the cutting edge, oriented relative to the direction of speed of the main movement. It is used for approximate calculations of blade angles during cutting and accounting for changes in these angles after installing the tool on the machine and is a transition system from the instrumental coordinate system to the kinematic.

Kinematic coordinate system – a rectangular coordinate system with a beginning at the point of the cutting edge, oriented relative to the direction of the speed of the resulting cutting movement.

The system of coordinate planes (Fig. 7) includes: the main, the working plane, the cutting plane, secant planes.

Base Plane P_v – coordinate plane drawn through the considered point of the cutting edge perpendicular to the direction of the speed of the main or resulting cutting movement.

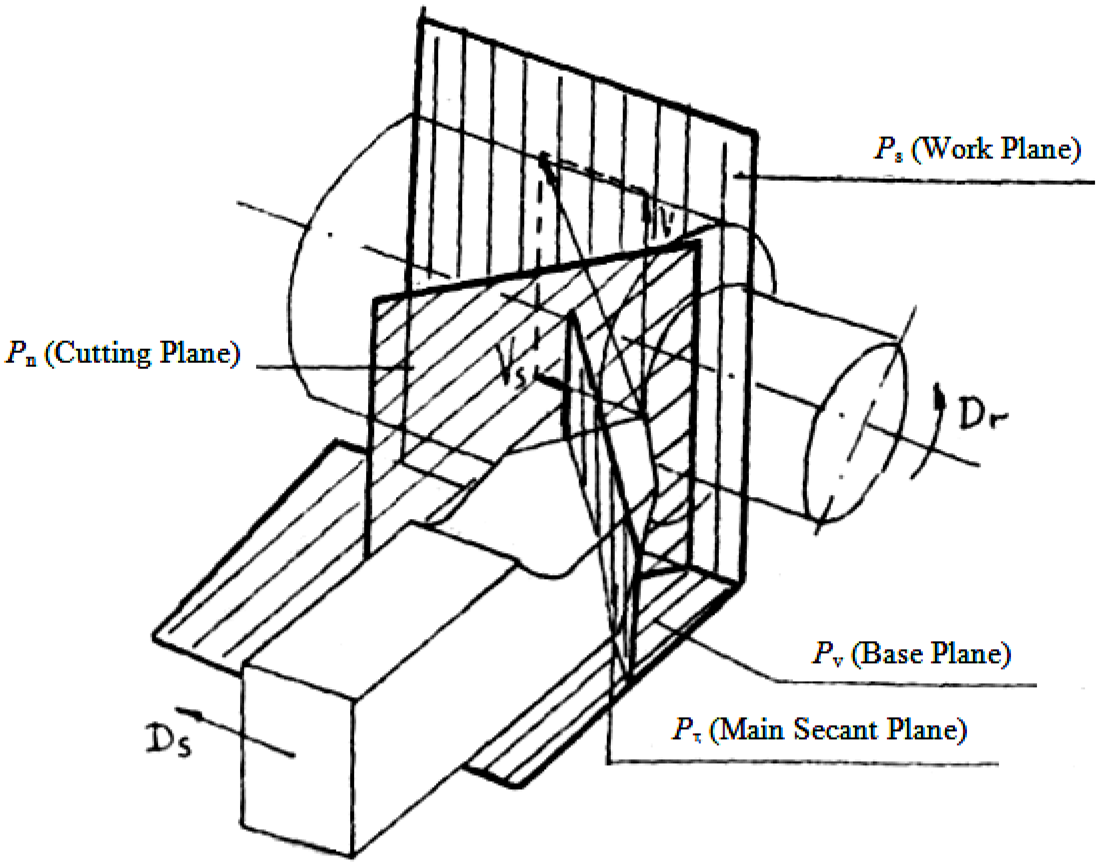

Fig. 7. The System of Coordinate Planes

In the instrumental coordinate system, the direction of the speed of the main cutting movement is taken: for turning and planing cutters of rectangular cross section – perpendicular to the design installation base, for grooving cutters – parallel to the base.

Cutting plane P_n – coordinate plane tangent to the cutting edge at the point in question and perpendicular to the main plane.

Main secant plane P_τ – coordinate plane perpendicular to the line of intersection of the main plane and the cutting plane.

Work plane P_s – the plane in which the directions of the speeds of the main cutting motion and the feed motion are located.

The cutting tool blades in space are characterized by the following angles (Fig. 8):

Front angle γ – the angle in the secant plane between the front surface of the blade and the main plane. It has a positive value when the front surface is directed downward from the cutting edge, and a negative value when the front surface is directed upward.

Back angle α – angle in the secant plane between the rear surface of the blade and the cutting plane;

The angle of taper β – the angle in the secant plane between the front and rear cutting surfaces;

Edge angle λ – angle in the cutting plane between the cutting edge and the main plane. If the tip of the cutter is the lowest point of the blade, then the angle has a positive value, if the highest, then negative.

Main angle in plan φ – the angle in the main plane between the cutting plane and the working plane.

When considering these angles in different coordinate planes, they are indicated by symbols that define these coordinates (instrumental - U, static - C, kinematic - K).

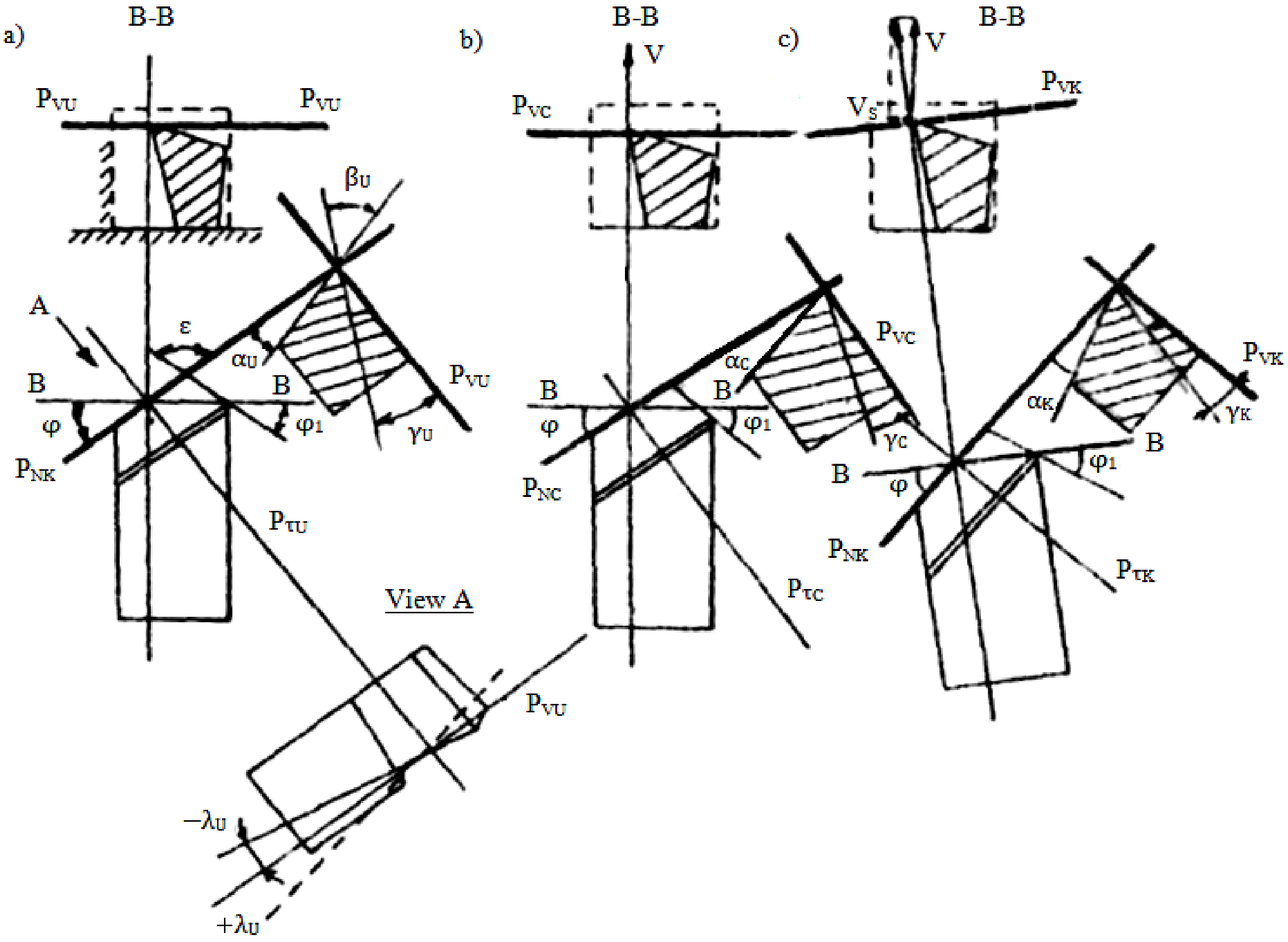

Fig. 8. Systems of Coordinate Planes and Geometrical Parameters of Cutters: a) Instrumental, b) Static, c) Kinematic

3. Angle measurement. The practical determination of the geometric parameters of real incisors is carried out using desktop/table goniometers design MIZ, universal goniometer. Measurement schemes of the front and rear angles, angles in the plan, the angle of inclination of the cutting edge are shown in Figs. 9-11.

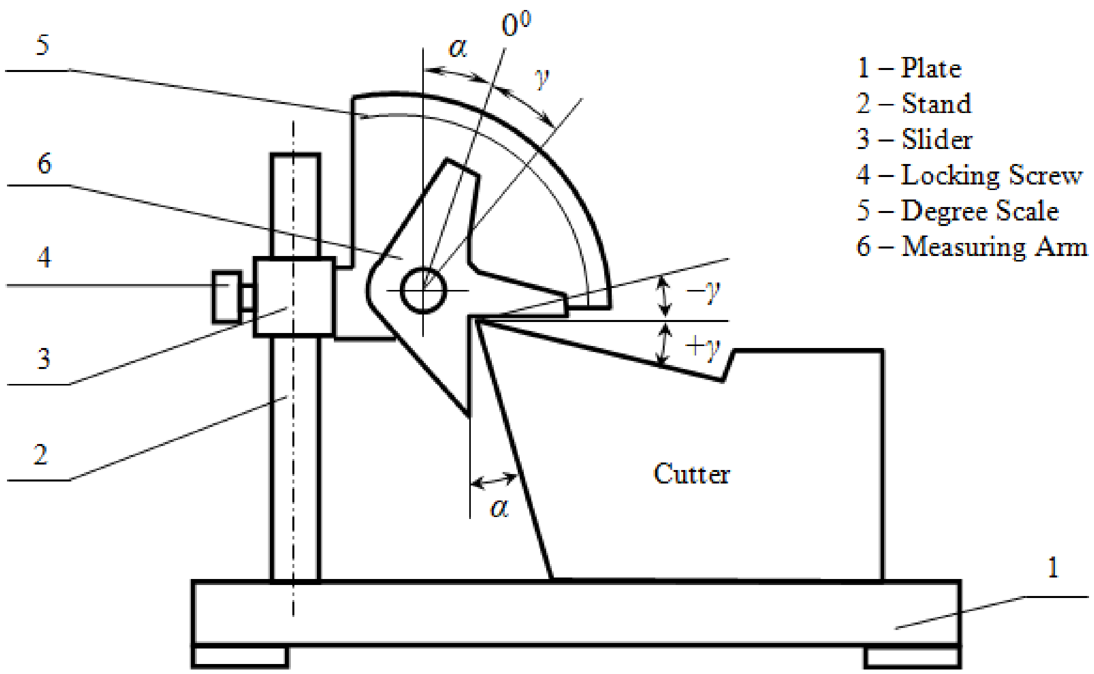

Fig. 9. Desktop Goniometer MIZ

The desktop goniometer MIZ has a plate 1, on which the measured cutter is mounted (Fig. 9). A rack 2 is fixed on the plate, along which the slider 3 moves with a degree scale 5. Using the locking screw 4, the slider can be fixed in any position relative to the rack. On the degree scale there is a rotary measuring arm 6. The upper arm of the lever has a risk at the end, which is oriented with the degree (measuring) scale. The lower shoulder has two mutually perpendicular faces. The risk of the lever coincides with the zero of the measuring scale in the case when one measuring face is in the horizontal position and the other in the vertical. When measuring principal angles, the plane of the measuring sector is set to the corresponding position of the plane where these angles are measured (in the main secant plane α and γ; cutting plane λ; in the main plane φ and φ_1). The upper or lower measuring face 7 is aligned with the plane of the cutter, which corresponds to the determined angle. The angles in the main secant plane are interconnected by the following relationships:

$$\alpha + \gamma + \beta = 90^0;\ \delta = \alpha + \beta$$

Angles in plan:

$$\varphi + \varphi_1 + \varepsilon = 180^0.$$

The table goniometer (Fig. 10) is a universal device that allows you to measure all the corners of the cutter. The construction is noteworthy in that there are three mutually perpendicular measuring sectors on the slider.

Fig. 10. Table Goniometer

Fig. 11. Universal Goniometer

In this virtual laboratory work, the measurement of geometric parameters is carried out using the sliding coordinates of a dial in the range 0–360 degrees. The division value is 1 degree.

<u>Lab Work Order:</u>

1. Get 1-2 version of incisors proposed by the teacher from the electronic database.
2. According to the processing schemes and drawings of the cutters, study their purpose, design, and perform their classification.
3. Perform kinematic schemes issued by the cutters and a sketch of one (any) of them with the necessary sections and an indication of its linear and angular parameters.
4. Measure the basic geometric parameters (angles) of the cutters using the sliding coordinate axes.