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A New Pass-Through Lathe Cutter

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Abstract—A new pass-through lathe cutter is described. Its cutting edge is formed by primary and secondary cutters so as to improve cutting and shaping.

Keywords: turning, finishing, lathe cutters, quality enhancement, durability, single-edge cutter, geometry, cutter design

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In machining by traditional lathe cutters, the tip of the tool results in unstable surface quality [1–3]. Disadvantages of the traditional design include the formation of a helical distorted triangular machined surface with rapidly changing theoretical external contact lines (instead of the theoretical cylinder); and relatively fast cutter wear, with corresponding increase in diameter of the plant and decrease in tool life.

In the present work, a new pass-through lathe cutter without such disadvantages is proposed, along with a corresponding machining method for the external surfaces of solids of revolution (such as cylindrical rollers and conical surfaces). The cutting edge of the new design is formed by primary and secondary cutters aligned along a single line. The operation of the new pass-through lathe cutter is illustrated in Fig. 1a.

In removing large margins (in roughing) and with large cutting depth, the new design increases the cutting power and reduces the machining efficiency. Therefore, the new pass-through lathe cutter is used in finishing the external surfaces of rollers, bushes, pins, cones, and similar components. Its use reduces the influence of radial and longitudinal vibrations on the surface roughness; and maximizes the similarity of the machined surface and the theoretical cylindrical surface, thanks to contact of the straight cutting edge and the machined surface.

In Fig. 1, the notation is as follows: (*1*) blank; (*2*) new pass-through lathe cutter; (*3*) three-jaw chuck; (*4*) direction of rotation of the blank (machined part); (*5*) direction of cutter supply; (*6*) chip; α is the rear angle; γ is the front angle; A–C' is the projection width of the chip.

In view L, λ is the inclination of the cutting edge relative to the direction of cutter supply and the axis of the blank. The chip width $AC'' = AC'/\sin\lambda$. In Fig. 1d, $AC = AC''/\tan\xi$.

The proposed design has one rear surface and one rear angle. To create better cutter and shaping conditions, the working section lacks a tip. (The primary and secondary cutters are aligned along a single line and form a single cutting edge, with a plane angle of

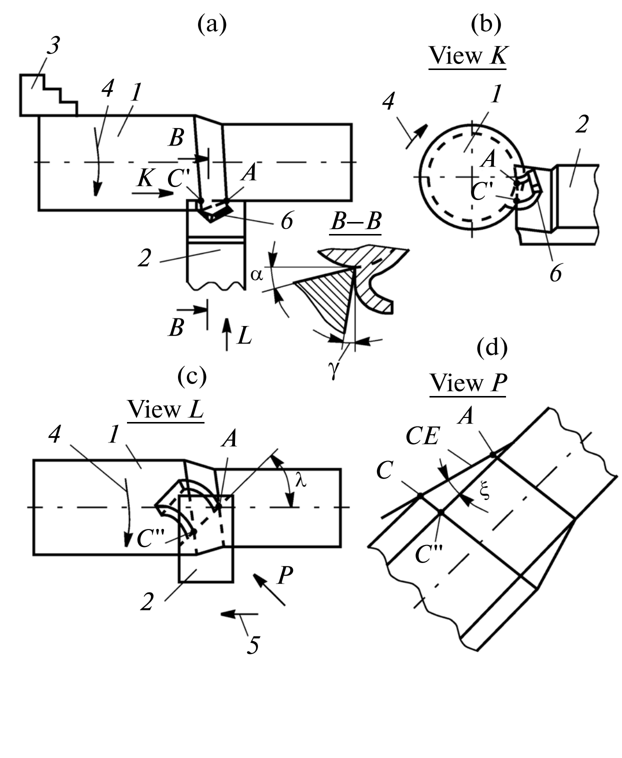

Fig. 1. Operation of pass-through lathe cutter (a) and its position with respect to the blank in view *K* (b), view *L* (c), and view *P* (d); CE, cutting edge.

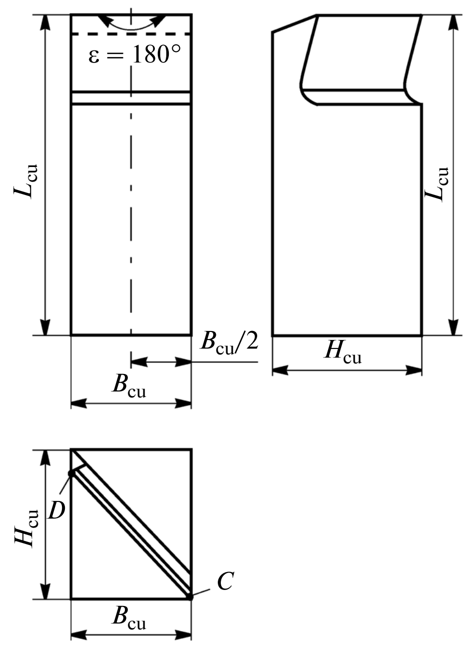

Fig. 2. Design of the pass-through lathe cutter.

180°; the conventional position of the excluded tip is at the point of intersection of the cutting edge with the handle's longitudinal symmetry plane.) The single cutting edge is perpendicular to the cutter's longitudinal axis and is in a working plane perpendicular to the primary plane and tangential to the machined surface.

The theoretical contact point of the cutter and the machined surface at contact, with zero cutting depth, is on the generatrix in a horizontal plane passing through the blank's axis. At the theoretical contact point (at the midpoint of the contact line between the cutter and the cut layer), the cutting edge is actually divided into primary and secondary components from a kinetic perspective; that is associated with the curvature of the machined surface in the cross section.

Thus, in operation, equal primary and secondary plane kinematic angles are noted. Therefore, the proposed pass-through lathe cutter has variable primary and secondary plane kinematic angles and variable inclination of the cutting edge, with a single rear angle. (The variable angles tend to zero at the theoretical central contact point with the machined surface. That corresponds to the presence of an effective smoothing edge at the actual contact line.)

The division of the cutting edge into primary and secondary components (in connection with the appearance of actual primary and secondary kinematic plane angles beyond the actual contact line with the cutting surface) is conventional, since the position of the theoretical contact point depends on the unregulated position of the pass-through lathe cutter (in terms of its height in the holder), which is adjusted so as to permit the use of the whole length of the cutting edge and the total cutter capacity; the cutter's rear angle remains constant. At the upper and lower sections of the cutting edge, a protective groove is introduced.

In the machining of shafts with channels between their sections, the lower part of the cutting edge may be inclined to the left at its exit point from the handle and may have the corresponding recess. In other cases, the vertical position of the cutter is adjusted so as to permit complete use of the cutting edge.

The new tool design is shown in Fig. 2, where C and D are the extreme points (limits) of the cutting edge; B_{cu} is the cutter width; $B_{cu}/2$ is the distance to the longitudinal symmetry plane of the cutter handle; H_{cu} is the cutter height; and L_{cu} is the cutter length.

When using the proposed pass-through lathe cutter, the cutter wear is reduced; cutter life is increased; and the machined surface is of better quality (with reduced roughness, which is especially important in finishing). The new tool is characterized by increased blade strength and reduced stress and thermal stress at the cutting edge. In the central area of the contact zone between the cutting edge and the blank good conditions for finishing of the machined surface by the straight cutting edge are created.

The pass-through lathe cutter has a single cutting edge; is simpler than the traditional design, since it lacks a secondary rear surface and a tip; is easier to manufacture and to sharpen; and consequently ensures lower operating costs. Its design includes upper and lower protective edges, although they are rarely needed. The pass-through lathe cutter may be manufactured from high-speed steel or equipped with hard-alloy or other high-performance plates. The vertical position of the pass-through lathe cutter in the handle is adjusted by means of special regulatory plates, so as to bring new sections of the cutting edge into action.

In kinematic terms, the pass-through lathe cutter has five geometric parameters (angles), thanks to the elimination of the secondary rear plate: (1) the front angle; (2) the rear angle; (3) the inclination of the cutting edge; (4) the primary kinematic plane angle; (5) the secondary kinematic plane angle. (The primary and secondary kinematic plane angles are not measured but calculated.) The primary and secondary static plane angles are zero. Accordingly, in static terms, the pass-through lathe cutter has only three geometric parameters: (1) the front angle; (2) the rear angle; (3) the inclination of the cutting edge. By contrast, in static conditions, the traditional pass-through lathe cutter has six angles.

Thus, the proposed pass-through lathe cutter increases the efficiency in finishing the external surfaces of solids of revolution. The absence of a cutter tip greatly increases the total tool life; enhances the quality of the machined surface; and reduces the temperature and load at the cutting edge.

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