PROJECT OF NON-CIRCULAR STAMPING DRAWING
FROM THIN SHEET-METAL

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Abstract
Paper concerns blank development and rationalization of production of intricate shape stampings - left and right side of hand-operated cutter of grass RST 450. For proposing of shape of blank of side proved true the graphical method, which uses the maximum shear stress trajectories. For quick and ready manufacturing of blanks of intricate shape from the sheet-metal tables proved true the machine Trumatic 240 rotation.

For the experimental drawing proved true the press CBJ 250-5, which has the possibility of slow move of the slide during drawing and the possibility of stopping it in arbitrary position, which makes possible to follow up visually the whole process of drawing.

On the eccentric press LE 160-C, which has small stroke (20 ÷ 120 mm), the drawing tool with blankholder in the form of fixed steel plate, fastened to the drawing die, with the distance steel piece between the plate and the die can be used. This distance piece by its shape secure the precise location of formative blanks in drawing tool before drawing and by it arising of the same stampings.

Using the blankholder and the optimal shape of blank makes possible to make in every working stroke of the press the stamping of side straight to be ready and without waviness in corners. Simultaneously the operation of grinding of the upper edge of vertical faces of the stamping after drawing and the operation of punching out of slot in the vertical face of stamping for the adjustable knife are removed.

INTRODUCTION
The enterprise Kovopodnik Ostrava produces the hand-operated cutters of grass RST 450 with adjustable knife and rotary cutter cylinder, the drive of which is ensured by geared transmission from the travel wheels of the cutter. The total production is about 6000 cutters in a year.

Considering that the enterprise has the offer of the possibility to export these cutters abroad, but only with the condition of decrease of their total mass, in the enterprise arose the effort of decrease of mass of some components. Because the most heavy components of cutter were the left and right side, which were produced from sheet-metal from the steel 11 321.21 with thickness of 2,0 mm ČSN 42 6312.31, the designers were interested in decrease of mass just of these components by proposing of the new semi-product - sheet-metal from steel 11 321.21 with thickness of 1,0 mm ČSN 42 6312.31. The thickness of sheet-metal was not proposed smaller than 1,0 mm with regard to the fact, that the other components are fixed to the left and right side by spot welding.

1 ORIGINAL PRODUCTION TECHNOLOGY OF SIDES FROM SHEET-METAL WITH THICKNESS OF 2,0 MM
The blanks for drawing of stampings of the left and right side of cutter were produced from sheet-metal tables from steel 11 321.21 with thickness of 2,0 mm ČSN 42 6312.31 in one blanking tool thanks to the mirror symmetry of shapes of these sides. The drawing tools without blankholders were used for drawing of stampings of sides. The drawing was realized on the eccentric press with fixed table LE Š60-C (manufacturer: Závody t'ažkého strojárstva, n. p. Košice, Czechoslovakia). The lubrication during drawing was realized by silicon oil in sprayer SILKAL 90.

During drawing of stampings of sides (see Fig. 1.1) the moderate waviness of vertical faces in corners of the stamping and irregular upper edge of the stamping was arisen. This irregular upper edge was grinded after drawing. The punching out of slot in the vertical face of stamping for the adjustable knife was the additional finishing operation on sides.
2 DRAWING OF SIDES FROM SHEET-METAL WITH THICKNESS OF 1,0 MM

During drawing of sides of cutter in the new drawing tools, which were adapted to the sheet-metal with thickness of 1,0 mm, without blankholders, the great waviness of vertical faces and entirely wrinkles in corners of the stamping have been arisen (Fig. 2.1). Considering that the shape of blank was not optimal, the heights of the upper edge of the vertical faces has not been up to demands in the working drawing.

The blanks and the stampings of sides made from them with great waviness of vertical faces and wrinkles in corners

The endeavour of rationalization of production in a short term has brought the enterprise Kovopodnik Ostrava to the co-operation with the author of this paper. The aim of co-operation was optimization of shape of blank and also optimization of the process of drawing of stampings of sides from the sheet-metal with thickness of 1,0 mm in order to be possible to
make in one working stroke of press the stamping of side straight to be ready and without existing waviness in corners and without wrinkles. The additional aim was removing of operation of grinding of the upper edge of vertical faces of the stamping after drawing and also removing the finishing operation on the sides, e.g. punching out of slot in the vertical face of stamping for the adjustable knife by proposing of suitable shape of a slot straight in the blank.

3 THE PROPOSAL OF SHAPE OF BLANK AND MANUFACTURE OF IT

The proposal of shape of blank for the stampings of the left and right side was made by the author by the graphical method, which uses the maximum shear stress trajectories.

The substance of this method is in constructing of the maximum shear stress trajectories (the M. S. S. T.) network round the outline of contact of draw punch with blank at the beginning of drawing, which moves with the speed, which is equal to the speed of draw punch thanks to friction between draw punch and sheet-metal. Then the outline curve of blank is drawn to the M. S. S. T. network with keeping to the condition, that it must intersect the M. S. S. T. network with the angle ± 45°, and with keeping to the condition, that the area of determined blank (with considering the technological trimming allowance) may correspond with the surface of final stamping.

The shape of blank was proposed with the slot for the adjustable knife of cutter in order to remove the finishing punching operation.

Considering that first of all the final shape of blank, from which it would be possible to draw the stamping straight to be ready, was not known, the checking blanks were manufactured in the machine Trumatic 240 rotation (product of the firm Trumpf from West Germany).

Because the blank with the intricate shape is one of the complicated parts, its shape was first of all externaly programmed by the programme system Trumpf TC-APT.

Then the blanks were manufactured from sheet-metal table by successive piercing, during which the tool vibrated with the frequency of 280 strokes in a minute. The outline of the external shape of blank arose successively during unceasing move of the ram. The guide of workpiece was secured by the control unit CNC.

4 THE EXPERIMENTAL DRAWING AND PROPOSAL OF BLANKHOLDER

The experimental drawing was made in the enterprise Kovopodnik Ostrava on the press CBJ 250-5 with maximal stroke of 600 mm. The principal advantage of this press contrary to the eccentric press was the possibility of slow move of the slide during drawing and the possibility of stopping it in arbitrary position. The whole process of drawing could be visually followed up and evaluated.

The arising of moderate waviness of vertical faces in corners of the stamping during drawing and calculations according to ČSN 22 7303 and ČSN 22 7301 showed, that the blankholder must be used for achieving of smooth vertical faces.

The proposal of the blankholder with springs according to ČSN 02 6001 and ČSN 02 6003 was not used, because the eccentric press LE 160-C, on which the sides of cutters are to be made, has small stroke (20 ÷ 120 mm) and because the total blankholding force, which can be achieved by springs, is small. The area of blank under the blankholder was $S = 12720 \text{ mm}^2$, the necessary force of the blankholder $F = (1.8 \div 2.8) \times 12720 = 22896 \div 35616 \text{ N}$.

According to the reasons, mentioned above, the blankholder was proposed in the form of fixed steel plate fastened by bolts to the drawing die with the distance steel piece with thickness of 1.1 mm between the plate and the die. The distance steel piece by its shape secured the precise location of formative blank in drawing tool before drawing and by it arising of the same stampings.

By drawing of sides with this type of blankholder the stampings with smooth vertical faces without waviness (Fig. 4.1) have been arisen already. Considering that the sheet-metal get thinner during drawing and simultaneously stretches, it was necessary to carry out small corrections of shape of blank in order to the arisen stamping has the heights of the upper edge of the vertical faces exactly up to demands in the working drawing. The correct function of the tool and the proposed shape of blank (Fig. 4.2) were then checked on the eccentric press LE 160-C. According to the final shape of blank the punching tool for production of blanks from sheet-metal was manufactured.
5 CONCLUSIONS

a) For proposing of shape of blank of the left and right side of hand-operated cutter of grass RST 450 proved true the graphical method, which uses the maximum shear stress trajectories).

b) For quick and ready manufacturing of blanks of intricate shape from the sheet-metal tables proved true the machine Trumatic 240 rotation.
c) For the experimental drawing proved true the press CBJ 250-5, which has the possibility of slow move of the slide during drawing and the possibility of stopping it in arbitrary position, which makes possible to follow up visually the whole process of drawing.

d) On the eccentric press LE 160-C, which has small stroke (20 ÷ 120 mm), the drawing tool with blankholder in the form of fixed steel plate, fastened to the drawing die, with the distance steel piece between the plate and the die can be used. This distance piece by its shape secure the precise location of formative blanks in drawing tool before drawing and by it arising of the same stampings.

e) Using the blankholder and the optimal shape of blank makes possible to make in every working stroke of the press the stamping of side straight to be ready and without waviness in corners. Simultaneously the operation of grinding of the upper edge of vertical faces of the stamping after drawing and the operation of punching out of slot in the vertical face of stamping for the adjustable knife are removed.

REFERENCES

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