

**Necessity of specific holddown pressure adjustment
when drawing operation**

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Abstract

The article deals with the issue concerning with the holddown pressure creation when deep drawing of blanks made of sheet metal. It indicates that the specific force does not remain constant, but increases with a decrease in the flange area. Thus, the usage of mechanical presses may result in separation of bottom or flange. The design of mechanical press for drawing is proposed. It has a connection with drawing and blank holder that is carried out by using hydraulic cylinders. This design allows you to adjust the specific holddown pressure within optimal limits.

Key words: POWER, PRESS, CRANK RADIUS, PRESS HARDNESS, PRESS HEIGHT

It is known [1] when drawing the blanks of thin material it is necessary to carry out the holddown pressure of the blank to the matrix. The application of holddown pressure eliminates ruffles that are observed when blanking from thin materials. At the same time researches both theoretical and experimental show that holddown pressure required to prevent the formation of ruffles when the drawing process does not remain constant. On the crank presses when drawing, for example, circular in plan products, the area of the flange, which contacts with the matrix and the hold-down pressure is reduced, the pressing force remains constant, and its value is determined by [1]:

$$Q_{hd} = 0,25\pi[D^2 - (d_1 + 2r_m)^2]q$$

where: D - blank diameter;
 d_1 - diameter of semi-finished product;
 r_m -curvature of matrix;
 q - specific pressure of the holddown.

Tension from the holddown pressure (with drawing ratio close to the limit) is encouraged to identify, according to [2] ratio:

$$\sigma_{p_{max}} = \sigma_s \left(\ln \frac{R}{r} + \frac{\mu Q}{\pi R S \sigma_s} + \frac{S}{2r_m + S} \right) e^{\frac{\mu}{2}}$$

where σ_s - tensile strength;
 R - blank radius;
 r - punch curvature radius;
 μ - friction coefficient;
 S - blank thickness;
 r_m - matrix curvature radius.

Thus, the holddown pressure is determined from the initial sizes of the blank and the drawing process remains constant leading to an increase in specific holddown pressure.

Obviously, the adjustment of holddown pressure will reduce the stress in the dangerous section and expand opportunities the drawing process.

In [3] there proposed the following approximate dependency to determine the holddown pressure Q at any moment of the drawing process:

$$Q = \beta Q_m \sin \left(\frac{\pi}{2} \cdot \frac{H_x}{H_m} \right)$$

where β - coefficient, $\beta = 1,1 \div 1,25$

Q_m - the greatest holddown pressure, which, for example, is determined according to [2]

H_x - current depth value of the drawing

H_m - maximum depth of the product.

Researches carried out [3] at a constant and a variable holddown pressure have shown that in the latter case it is possible to reduce the drawing coefficient by 10-12%. Studies have been performed on the double action mechanical presses and have shown that at the beginning of the drawing process press develops holddown pressure, which greatly exceeds not only necessary at the moment, but also exceeds the hold-down pressure required for the entire process. At elevated holddown pressure not only the radial stress in the weak section at the beginning of the process increases but also the local necking in the contact zone of the blank with the punch increases [1], which reduces the capability of the whole process. This character of change of specific holddown pressure occurs in all double action mechanical presses, and leads to increased wear of the mechanism and extra energy expenditure. [3]

If we consider the process of drawing the circular in plan products (Fig. 1), we can eliminate step of the cylindrical part of the product appearance on which the current area of the flange located under the hold-down is determined as follows:

$$F_{current} = F_0 - F_2 - F_3 - F_4 - F_5, (1)$$

where

F_0 - blank area;

F_2 -transient area on the matrix;

F_3 - product cylindrical part area;

F_4 - transient area on the punch;

F_5 - bottom area.

According to [1], the area of these elements is determined as follows:

$$F_2 = \frac{\pi}{4} (2\pi d_u \cdot r_m - 8r_m^2);$$

$$F_3 = \pi d_n H_u;$$

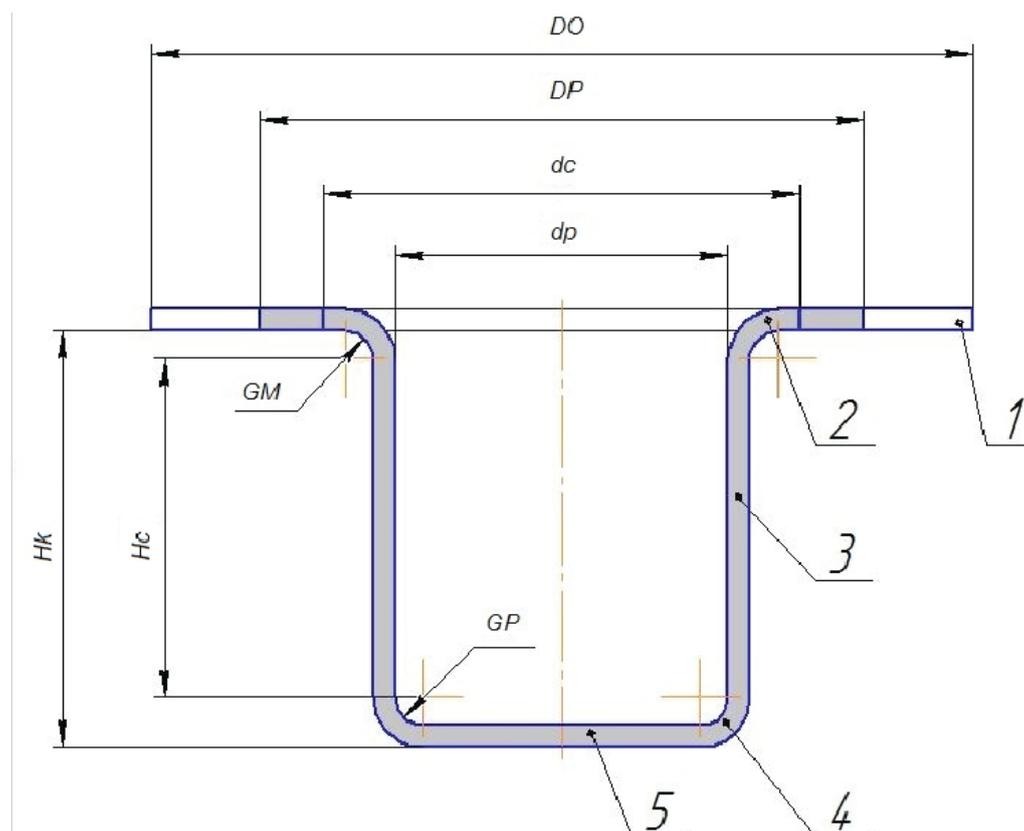


Figure 1. Distribution of circular products on the calculated elements.

$$F_4 = \frac{\pi}{4} \left[2\pi(d_n - 2r_n) \cdot r_n + 8r_n^2 \right];$$

$$F_5 = \frac{\pi}{4} (d_n - 2r_n)^2$$

After appropriate transformations we obtain the following dependence for determining the area $F_{current}$:

$$F_{current} = A - B \cdot H_y \quad (2)$$

Where A and B are constants that are equal to:

$$A = F_0 - F_2 - F_4 - F_5$$

$$B = \pi d_n$$

Analyzing the above information we can draw a conclusion about the necessity of adjustment hold-down pressure as the slide travel function of the press progress. On mechanical presses without design changes of kinematic connection of the drawing slide with the hold-down slide realization of the hold-down pressure adjustment is impossible; on hydraulic presses it requires to mount the pressure controllers in the hydraulic drive cylinder of hold-down slide with the realization of dependence (2).

On mechanical presses implementation of this dependence requires connection of the drawing and hold-down slide by, for example, hydraulic cylinders, their pressure when drawing process would vary according to necessary laws.

The scheme the implementation of such a method of creating the necessary hold-down pressure (a possible variant) is shown on Fig. 2.

As pressure controller in cylinders, pressure controller or an adjustable restriction, the capacity of which, depends on the stroke of the slide, can be used.

For considerable stroke of the slide it can be encouraged to use the drive which slide full stroke is equal to four crank radius [4, 5, 7, 8, 9, 10].

The outer slide 1 kinematically connected to the drawing slide by means of hydraulic cylinders 2 which are rigidly fixed to the inner (outer) of the slide 3. The operation of the hydraulic cylinders is carried out by the electrohydraulic rotary slide valve 4 and 4a.

Closed pressure manifold 5 is a generator of liquid elevated pressure. The waste liquid is discharged to the tank 6 through the conduit 7.

The cylinder piston side 2 connected with the discharge through an adjustable pressure surplus valve 8 driven by the slide 3.

As can be seen from the hydraulic scheme other implementation of various laws of the pressure changing in the piston sides is possible.

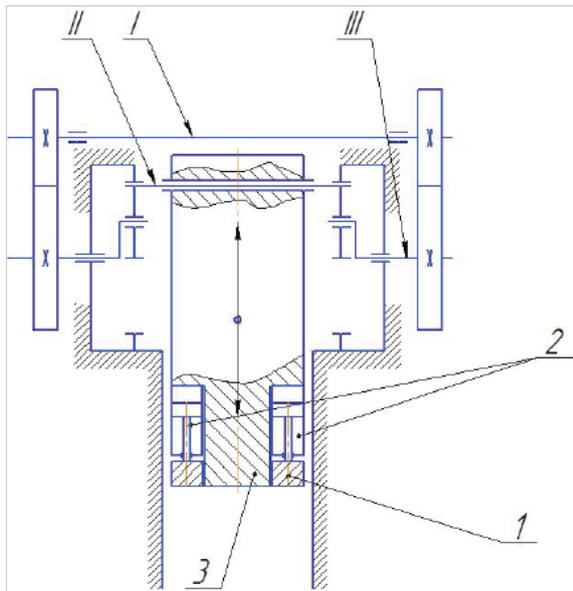


Figure 2. Scheme of method for creating the required holddown pressure.

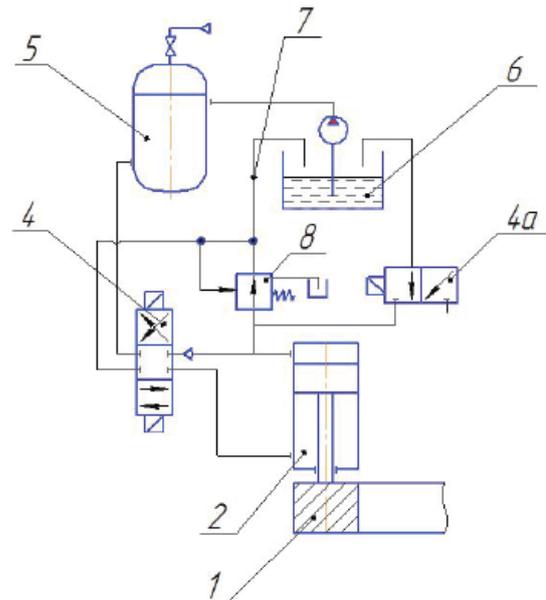
Thus in the case of the implementation of the pressure adjustment in the piston slides of the drive cylinders of the holddown slide the wall thinning and reduction ratio can be greatly reduced when improving the stability of the drawing process.

Conclusion

The article gives recommendations for the practical use of the work results. Developed engineering solution with respect to the planetary gear of the mechanical press is recommended for application as a main actuating mechanism for drawing presses, which makes possible to reduce the dynamic loads, to increase the hardness of individual units, to reduce the height of the press and to increase the stroke.

Developed technical solution allows us to apply the main actuating mechanism in the drawing presses of double action. This solution the lever mechanisms are replaced by hydro mechanical, that allows us to considerably simplify the HAM (hydro mechanical actuating mechanism) when decreasing the height of the press. As the drive of the inner slide having a considerable stroke the planetary gear is used with parameters that gives an opportunity to provide a stroke to the inner slide equals four crank radii. The press is adjustable to the required holddown pressure.

The proposed solution can be used as a main actuating mechanism in the nail making automatic presses. Due to this solution the design of the automatic press gives the opportunity for one and the same radius of the crank to get twice more slide stroke with a purely sinusoidal motion of the latter. In addition, it enables to set the working tool on both sides of the slide and have at the same amount of the strokes double performance or at the same performance twice



minimal number of strokes.

Studies suggest that in the case when the stroke is unchanged, the use of the planetary main actuating mechanism allows us (due to the absence of the connecting rod) to reduce the overall height by 25-45% with simultaneous reduction of the press weight by 30-45% when increasing the hardness of the frame, as well as reducing the center of gravity of the press at improving its dynamic stability.

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