THE SOLVING A COMPLEX CHAIN OF DIMENSIONS FOR A DRILL BY THE STATISTIC METHOD

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ABSTRACT: The works shows a possibility of solving the chains of dimensions on the basis of the statistic methods of calculus and passing step by step through a calculus methodology, so that the ratio between execution cost and the size of the tolerances granted for each primary element of dimensions chains be the best.

KEYWORDS: chain, dimensions, statistic method, drill.

1.Introduction.

One of the geometric features required in engineering is the hole. Drilling holes is probably the process best known to both engineers and non-engineers alike, as it is a regular activity in most jobs. Although it is possible to drill holes using a lathe by rotating the workpiece and feeding a stationary drill from the tailstock, all the machine tools in this family spin the cutting tool and feed it into stationary workpiece.

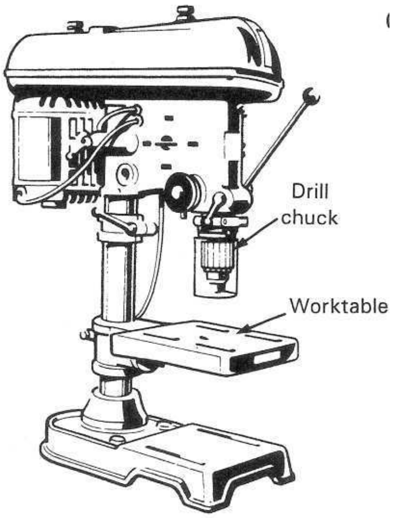

Figure1. Bench drill.

Drilling machines are available in a range of sizes, depending upon the maximum size of drill that they can hold, and range from small bench-type drills to large radial arm units capable of holding the largest twist drill sizes, fig.1 and fig.2 [5].

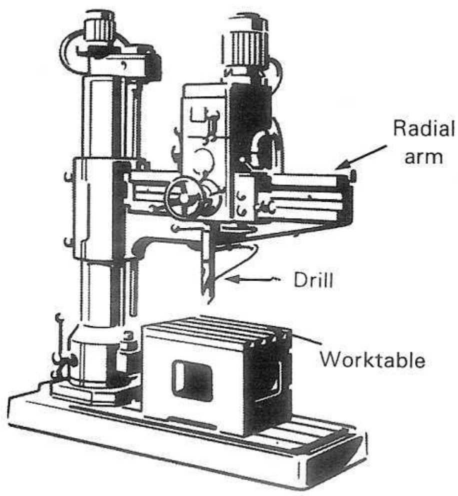

Figure 2 Radial arm drill.

The difference between drilling and boring is mainly a question of hole size. Although conventional drills of 50 mm diameter and more available, above approximately 30-40 mm they become more difficult to handle, so holes bigger than this are usually cut using a tool with a single cutting edge rotating at the radius of the required hole, fig.3 [5].

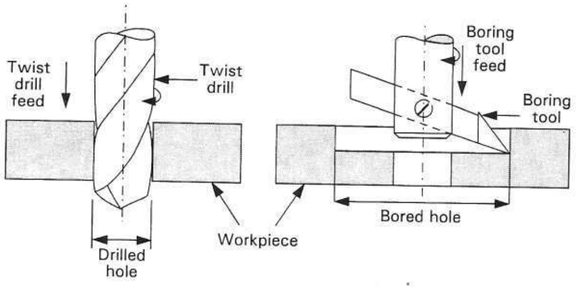

Figure 3. Difference between drilling and boring a hole.

This is termed boring and is also the method used to produce larger internal holes and circumferential grooves in work-pieces turned on lathes [1].

In addition to cutting deep boring machines are also capable of machining flat surfaces using either a single-point cutting tool held in a boring head and fed in a radial direction as it rotates or a face cutter typical of that used on milling machines for face milling.

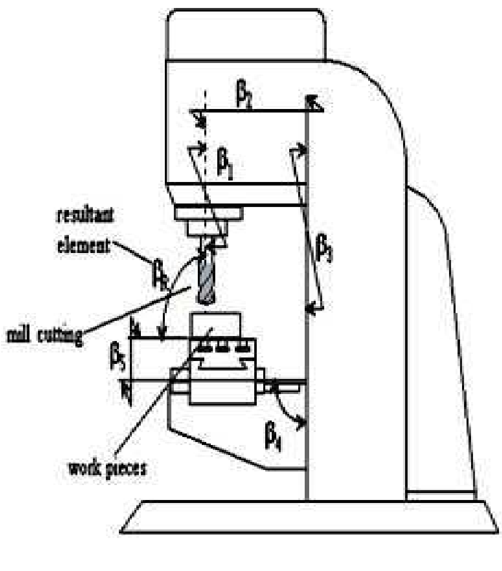

Figure 4. The chain of dimensions from perpendicularity between axle of the mill - cutting and the plan orientating surface

The work-piece is clamped onto the worktable of the and because the worktable can usually be swiveled accurately through any required angle it is easy to machine component faces and bore holes at precise angles relative to one another.

The works shows a possibility of solving the chains of dimensions on the basis of the statistic methods of calculus and passing step by step through a calculus methodology, so that the ratio between execution cost and the size of the tolerances granted for each primary element of dimensions chains be the best.

They shall analyze the solution of the dimensions chains determining the perpendicularity of the axle of the mill-holding shaft of the horizontal milling machine to the flat surface for directing the device where both the fastening and orientation of the semi-product are carried out, fig.4.

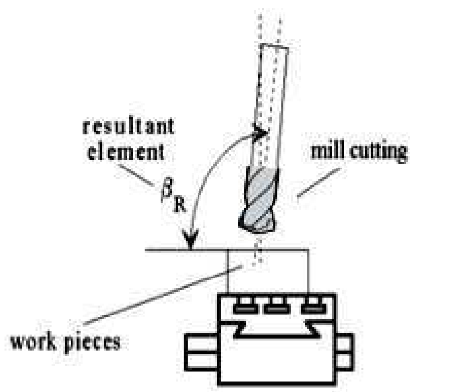

Figure 5. The Resultant element of the chain dimension, perpendicularity between axle of the mill- cutting and the plan orientating surface.

The elements composing the chain of dimensions are the following:

β_1 is the non-parallelism of the mill-cutting and the holding mandrel;

β_2 – the parallelism of the mill-holding mandrel to the machine column;

β_3 – non-straighteness of the guides of the bed;

β_4 - perpendicularity of the column of the machine table;

β_5 – the parallelism error of the orientation surface of the device designed for orientating and fastening the semi-product to the table of the machine-tool;

β_R – resultant element of the chain dimension, perpendicularity between axle of the mill- cutting and the plan orientating surface.

The perpendicularity between axle of the mill- cutting and the plan orientating surface of the device, the resultant element of the chain of dimensions, shall be within a certain limit, so that, from the working operation shan`t result rejected parts.

We shall take into consideration as influence elements the geometric characteristic of the mill-holding mandrel and the cutting.

The angle the mill-holding mandrel revolutes it self on a horizontal plane means, in fact, the primary element β_6 of the chain of dimensions, fig. 5.

2. Solving the dimensions chains.

The dispersion of the resultant element shall be calculated by relation (1) [3].

The dispersion of the elements primary:

β_1, β_2, β_3, β_4, β_5 shall be calculated by relation (2) [3].

$$\sigma_{\beta_R}^2=\left(\frac{\partial\beta_R}{\partial\beta_1}\right)^2\sigma_{\beta_1}^2+\left(\frac{\partial\beta_R}{\partial\beta_2}\right)^2\sigma_{\beta_2}^2+\left(\frac{\partial\beta_R}{\partial\beta_3}\right)^2\sigma_{\beta_3}^2+\left(\frac{\partial\beta_R}{\partial\beta_4}\right)^2\sigma_{\beta_4}^2+\left(\frac{\partial\beta_R}{\partial\beta_5}\right)^2\sigma_{\beta_5}^2+\left(\frac{\partial\beta_R}{\partial\beta_6}\right)^2\sigma_{\beta_6}^2 \quad \textbf{(1)}$$

$$\sigma_{\beta_1}=\sqrt{\frac{T_1}{36}},\quad \sigma_{\beta_2}=\sqrt{\frac{T_2}{36}},\quad \sigma_{\beta_3}=\sqrt{\frac{T_3}{36}},\quad \sigma_{\beta_4}=\sqrt{\frac{T_4}{36}},\quad \sigma_{\beta_5}=\sqrt{\frac{T_5}{36}}, \qquad \textbf{(2)}$$

The dispersion of the element $\boldsymbol{\beta}_6$, the revoluting angle, shall be calculated by the relationship (3), as follows:

$$\sigma_{\beta_6}=\left(\frac{\partial\beta_6}{\partial P}\right)^2\sigma_P^2+\left(\frac{\partial\beta_6}{\partial l}\right)^2\sigma_l^2+\left(\frac{\partial\beta_6}{\partial d}\right)^2\sigma_d^2 \quad (3)$$

The revoluting angle, presented in fig. 6, is given by the resistance calculus by relationship (4):

$$\beta_6=\frac{Pl^2}{2EI_p}\text{; so that } \boldsymbol{\beta}_6 = f\,(P,l,d) \qquad (4)$$

where:

P is cuttig force;

l - length of the mill-holding mandrel;

E – module of elasticity;

I – polar moment of initiation, $I_p=\frac{\pi d^4}{64}$;

d – diameter of the mill-holding mandrel.

Afterwards the standard deviation may be calculated and by this the tolerance of the resultant element shall be determined, talking for example, a field $\pm 3\sigma$:

$$T_{\beta_R}^2=\pm 3\sigma_{\beta_R}=6\sigma_{\beta_R} \qquad (5)$$

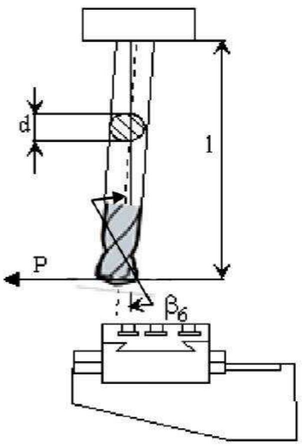

Figure 6. The primary element β_6,

the revoluting angle.

According to the proposed statistical method of calculus the reduction factor of the tolerance shall be calculated together with the tolerance increasing factor of the primary elements:

$$r = \frac{T^S_{\beta_R}}{T^A_{\beta_R}}, \qquad (6)$$

The new tolerances of primary elements shall be calculated by relationship (7):

$$T_{new} = \frac{1}{r} T_{old}, \qquad (7)$$

and afterwards the testing calculus of the dimensions chain shall be made with the new provided tolerances.

3. Conclusions.

The calculus of the tolerance of the resultant element of dimensions chain through the agency of the statistical method shall result in a less value got by applying the minimum and maximum method. That is why it is possible the primary elements of the chain have higher tolerances, so that, the value of the tolerances of the resultant element got by the new tolerances through the agency of the calculus by the statistical method be approximately equal to the tolerance of the resultant element, tolerance got through the agency of the minimum and maximum method under the conditions of the initial tolerances.

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