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FEATURES OF THE SCHEME OF BASING ON ROTATING ROLLERS AT AUTOMATIC ASSEMBLY OF THE THREAD CONNECTIONS

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ABSTRACT

The dependences for size of an error of basing are received with the circuit of basing of a detail on rotating rollers, that will allow to nominate the tolerances of the sizes of constructive elements of the automatic machine tool. The given circuit is applied with assembly of the thread connection (coupling-pipe).

Keywords: assembly, connecting details, basing device, error

1. ACCURACY OF RELATIVE POSITION OF CONNECTING DETAILS ON THE TECHNOLOGICAL BASIS

Ensuring of accuracy of relative position of connecting details on the technological basis before their assembling is one of the main stages of automation of assembly process.

If the scheme of basing is chosen correctly - the errors of relative position of connecting details do not exceed errors which are allowable according to conditions of assembly.

The design of basing devices depends on the geometrical form and sizes of connecting details, weight and physiomechanical properties of a material. Method has to be used for feeding connecting details into the assembly zone; required accuracy of basing; the kind of the used equipment of assembly and the transport device have an influence on the design of basing devices too [1].

Basing of connecting details like the shaft and bush on the working position of the automatic device can be performed by various ways, using their external or internal surfaces, namely:

- basing with using details' external dimensions or basing in a prism;
- basing with using external cylindrical surface;
- basing using external conic surface;
- basing using internal cylindrical surface and
- basing using internal conic surface.

Depending on a combination of these ways of basing it was deduced 25 ways of basing for details with cylindrical form [2]. The most typical schemes of basing of details on assembly rotors are shown in Figure 1. These shown eight schemes of basing are solved a problem of matching of details' axes and coupling of their cylindrical surfaces.

At automatic assembly on the multiposition equipment basing devices are blocked with transport device or directly mounted on the conveyors. As adjusting elements of basing devices - prisms, support, the centers, cylindrical and conic fingers, etc. are used. On the purpose its can carry out function of the fixed or directing basing.

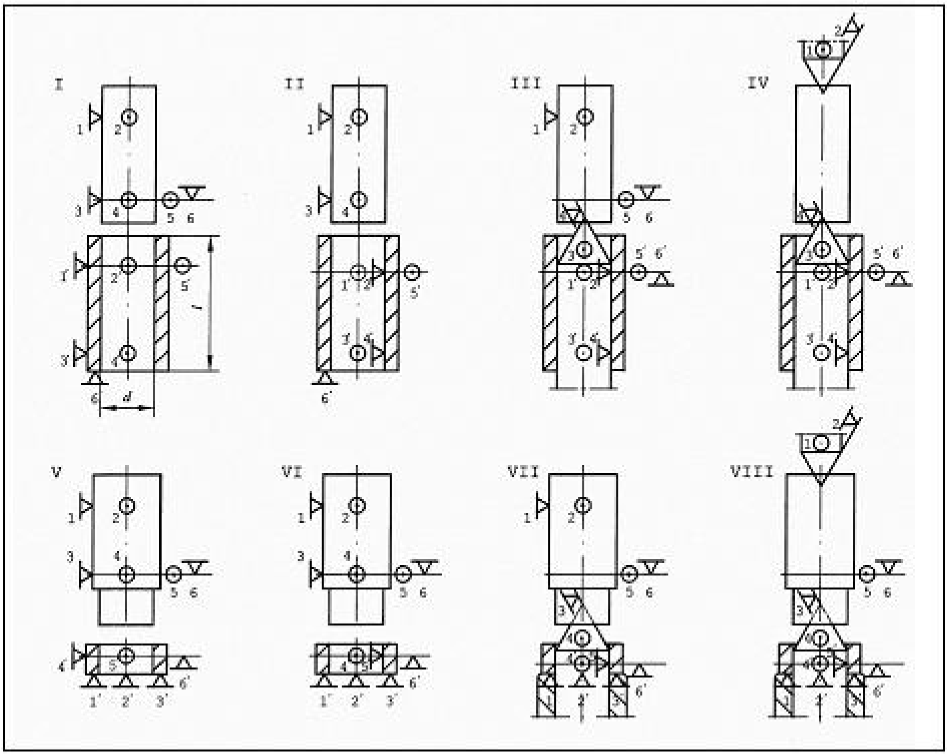

Figure 1. The schemes of basing that are solving a problem of coupling of cylindrical surfaces of details.

During assembly there are forces and the moments which are aiming to displace a basic part. To provide stability of basic part it is usually clamped in the basing device by means of tightening elements.

Elastic elements (springs, rubber rings, etc.) are using in the design of basing devices, to compensate a summary error of relative orientation of connecting details $\Delta\Sigma$ during their assembly. As a result due to elastic movings of basing devices appears an opportunity to correctly connect details' surfaces. And during their further connecting it will be possible to compensate axes' eccentricity and their displacement up to admissible limits.

The major factors that have influence on misalignment of axes of connecting details, for mentioned above basing schemes, are:

- errors of the diametrical sizes of details;
- errors of the geometrical form of surfaces of connecting details (curvature, ovality, obliquity, etc.);
- discrepancy of relative position of the connecting surfaces of details;
- discrepancy of relative position of the surfaces used as bases at placing in assembly devices;
- displacement of axes of basing devices;
- microroughness of surfaces of details and adjusting bases and other factors.

Depending on a choice of the mentioned schemes of basing - some of the listed factors influence on the accuracy of axes' coincidence of connecting details [3-5].

Research of ways of basing allows to reveal interrelation between accuracy of manufacturing of connecting details, accuracy of basing and conditions of assembly. Applying various ways of basing it is possible to change conditions of assembly of connecting details with the same tolerances and the same accuracy of basing devices in several times [1, 7].

Depending on the chosen scheme of basing of connecting details choose bunker, orienting, transport, control and other devices of assembly automatic devices.

2. BASING ON ROTATING ROLLERS

So, accuracy of relative position of connecting details depends, in particular, on the chosen schemes of basing [10]. At automatic assembly the scheme of basing with using the external cylindrical surface is widely applied, namely: pressing to a flat support and pressing to prismatic support. For a case when one from the details is pressing to the flat support, the error of basing ε_b in relation to an axis of detail's external surface is equal - to half of tolerance of diameter of detail's external cylindrical surface δ_e

$$\varepsilon_b = \frac{\delta_e}{2} \tag{1}$$

But in case of pressing to prismatic support

$$\varepsilon_b = \frac{\delta_e}{2\sin\left(\alpha/2\right)}, \tag{2}$$

where α - angle of a prism.

At automatic assembly of thread connections rotating rollers are used to combine processes of basing and rotation of one from two details (Figure 2).

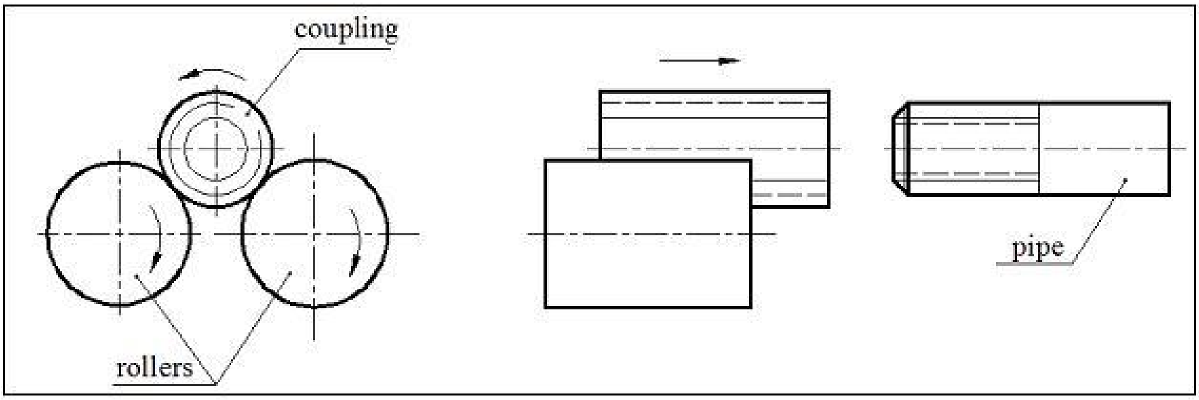

Figure 2. The scheme of basing on rotating rollers.

For the given scheme of basing of a detail on rotating rollers in the literature there are no information about value of an error of basing, therefore was a task to derive a formula for its definition.

3. ERROR OF BASING

Let's consider a problem of definition of an error of basing generally when radiuses of base rollers are various. The analytical scheme is shown in Figure 3. The entered following designations: $\mathbf{r_1}$, $\mathbf{r_2}$, – radiuses of rollers; $\mathbf{r_e}$ – radius of an external surface of a detail; **h** - distance from an axis of an external cylindrical surface up to a straight line which is passing through axes of rollers; $\mathbf{l_1}$, $\mathbf{l_2}$ – distances between axes of rollers and an axis of a detail; **m** – distances between axes of rollers.

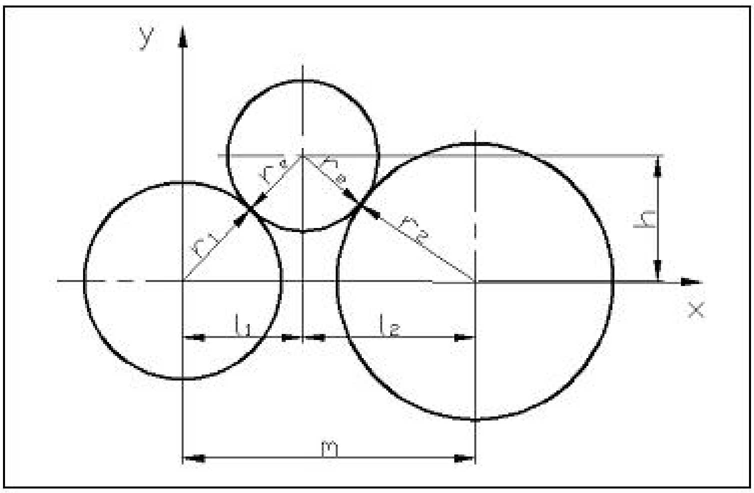

Figure 3. Analytical scheme.

Under Pythagorean theorem we receive expression

$$(r_1 + r_e)^2 = l_1^2 + h^2 \tag{3}$$

$$(r_2 + r_e)^2 = l_2^2 + h^2 \tag{4}$$

$$l_1 + l_2 = m \;\rightarrow\; l_1 = m - l_2 \tag{5}$$

$$(r_2 + r_e)^2 - (r_1 + r_e)^2 = m^2 - 2ml_1 \tag{6}$$

$$l_1 = \frac{m}{2} - \frac{(r_2 + r_e)^2 - (r_1 + r_e)^2}{2m} \tag{7}$$

$$h = \sqrt{(r_1 + r_e)^2 - l_1^2} \tag{8}$$

The received formulas (7) - (8) allow to define an error of basing εb in dependence not only on the tolerance of diameter of detail's external surface δe , but also tolerances of other constructive elements - diameters of rollers (**δ_1**, **δ_2**), axle base (**δ_a**), values of radial run out of rollers' surfaces at their rotation (**δ_{r1}**, **δ_{r2}**). The error of basing in a vertical direction is defined as a difference between the largest and least value of size **h**.
The error of basing in a horizontal direction also is defined as a difference between the largest and least value of size **l_1**. Values **l_1** and **h** can be defined under the formulas (9)-(12)

$$l_{1\max} = \frac{m+\delta_a}{2} - \frac{\left(r_2 - \frac{\delta_2}{2} - \frac{\delta_{r2}}{2} + r_e - \frac{\delta_e}{2}\right)^2 - \left(r_1 + \frac{\delta_1}{2} + \frac{\delta_{r1}}{2} + r_e + \frac{\delta_e}{2}\right)}{2\left(m + \frac{\delta_a}{2}\right)} \tag{9}$$

$$l_{1\min} = \frac{m-\delta_a}{2} - \frac{\left(r_2 + \frac{\delta_2}{2} + \frac{\delta_{r2}}{2} + r_e + \frac{\delta_e}{2}\right)^2 - \left(r_1 - \frac{\delta_1}{2} - \frac{\delta_{r1}}{2} + r_e - \frac{\delta_e}{2}\right)}{2\left(m - \frac{\delta_a}{2}\right)} \tag{10}$$

$$h_{\max} = \sqrt{\left(r_1 + \frac{\delta_1}{2} + \frac{\delta_{r1}}{2} + r_e - \frac{\delta_e}{2}\right)^2 - l_{1\min}^2} \tag{11}$$

$$h_{\min} = \sqrt{\left(r_1 - \frac{\delta_1}{2} - \frac{\delta_{r1}}{2} + r_e - \frac{\delta_e}{2}\right)^2 - l_{1\max}^2} \tag{12}$$

The received dependences allow to nominate the tolerances of the sizes of constructive elements of the automatic machine tool for assembly of the thread connection (coupling-pipe).

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