The influence of manufacturing errors of cases on their assembly

A S Yamnikov¹, E N Rodionova¹,² and I A Matveev²,³

¹FSBEI of HE "Tula State University", Tula, Russia
²JSC "NPO" SPLAV "named after A.N. Ganicheva, Tula, Russia
³E-mail: ivan_matveev@list.ru

Abstract. The authors of the article propose a way to increase the accuracy of processing pipe casings included in special products. Currently, in the current production of these products, there is a need to increase the accuracy of manufacturing cases, so it was decided to conduct research work. The article discusses the process of processing long bodies from thick-walled workpieces using hoods, which ensures high precision workpieces and minimal impact on the properties of the initial type of workpiece. As a result of the research, the significance of the geometric errors of the component pipes of the product on its functionality is analyzed. The achieved accuracy of the manufacture of base surfaces and the parameters of their possible distribution are shown. The similarity of the parameters of the initial part and further assembly is determined, it is also shown that the runout of the end surfaces of the part has a significant effect. The optimal basing scheme for finishing the end surfaces of long bodies is shown.

The technological process of processing and assembling special products has a great impact on products when they are used [1], therefore, considerable attention is paid to the study of the existing production of long bodies [2, 3]. The design of special products is shown (figure 1).

Figure 1. Design of a special product: 1 - plates; 2 block; 3, 5 docking elements; 4 - case; 6 head part; 7 - tip.

In contrast to the ideal option, in real production, all structural elements of special products are produced with specified tolerances. In particular, the centering thickenings of the housing, which at the same time are the docking elements with the head part and, on the other hand, with the block, have outer diameters machined according to the h9 and h11 qualifications, respectively.

Focusing on the geometric parameters that reflect the contour of special products, it turns out that during the final assembly, the axes of the components have a high probability of displacement and inclination. It is found that for products with significant lengths, the most important influence is exerted by the angular errors of the axes from the zero position. A sketch of the case, one of the most important components of the product, is shown in figure 2.
To control the radial runout of the center of the stem of the body and its end beats in the current production, the following complex is used (figure 3).

![Figure 2. Sketch of the body.](image)

**Figure 2.** Sketch of the body.

Experimental studies have shown that there is no effect of radial runout of the rollers on the accuracy of control, since it is less than the tolerance of the measured requirement - the radial runout of the body stem at a distance of 870 mm from end 1.

The end runout of the rollers also does not affect the accuracy of control, since the measured case with the disk 5 is constantly in contact with the latch 6. To control the runout of the ends, the case is mounted on the rollers 1 and brought into contact with the disk 5 with a fixed latch 6 (figure 3). Indicator 3 is brought to the end face 2 being checked and, when the case is rotated, the runout value of end 1 is determined by the difference in deviations of the indicator readings.

![Figure 3. Scheme of checking the face runout of the housing: 1 - rollers; 2 - end face No. 1; 3 - indicator; 4 - end face No. 2; 5 - disk; 6 – clamp.](image)
To control the beating of the end face 2, the body is rotated 180° and all actions are repeated again in the same sequence.

The radial runout of the central part of the stem of the body is controlled on the same complex, the indicator is also installed on a certain segment from the end 1 and, turning the product, determine the deviation of the runout.

On the basis of experimental control data, graphs were constructed (figures 4-6) for the beats falling into a given interval of values (dashed line). The figures also show the theoretical distribution (solid line), where the parameters and the level of agreement are calculated from the samples. Using computer processing of the source data, the curve of the exponential distribution of the runout values of the central part of the stem of the body was derived (figure 4).

Figure 4. Beating distribution in the center of the body.

Figure 5. Beating distribution of the first end of the housing.

Figure 6. Beating distribution of the second end of the housing.
The theoretical and practical distribution of the beat converges and is confirmed using the Pearson criterion.

Figure 7 shows the control pattern of the runout of the assembled product, where the runout of the central hole of the block is set. The assembly includes: 4 - bottom; 5 - a head tube; 6 - tail pipe; 7 - block; 8 - cone; 9 - nozzle.

The assembled set of centering structural elements A and B is installed on the rollers 1 and 2, brought to the lock 3. In the center of the nozzle 6 enter the indicator and the deviation of the arrow, determine the value of the runout.

Figure 7. Control of the central nozzle hole in the assembled kit: 1, 2 - rollers; 3 - clamp; 4 - bottom; 5 - a head tube; 6 - tail pipe; 7 - block; 8 - a back cone; 9 – nozzle.

During the study, measurements were made of the mass of the assembled sets, the beats of the center of the stem of the body and the beating of the center of the nozzle in a batch of 122 assemblies. The research result showed that the runout of the ends, in threaded joints with a threaded thread, has a significant effect on the radial runout of centering thickenings [4, 5].

To determine the type of the law of distribution of the studied quantities, the sample was divided into ten intervals, for each of which the frequency of experimental measurements was determined. The analysis of the experimental data made it possible to obtain the parameters of the distribution law for each parameter and calculate the theoretical indicators. Laws were verified using Pearson's test [6, 7]. Figures 8–10 show the results of approximating empirical data with theoretical relationships.

Figure 8. Mass distribution of assembled enclosures.
For the masses of assembled sets, the law of normal distribution is suitable (figure 8), for the runout of the central part of the stem of the body - the law of exponential distribution (figure 9), for the runout of the nozzle - the law of Rayleigh distribution (figure 10).

Analyzing the relationship between the frequency of the face runout of the housing (figure 6) and the frequency of distribution of the runout of the nozzle (figure 10), we determined that a correlation dependence is traced between them. The amount of runout of the nozzle increases with an increase in the end runout of the housing. Additional errors are introduced by the presence of additional links of the dimensional chain.

To significantly reduce the face runout of the bodies during the final machining, they were proposed to base them as follows: inside the guide, on the one hand, the body is mounted in a collet, abutting against the end face. On the reverse side, the clamp is proposed to be produced in a three-jaw chuck (figure 11).
The basement of longer bodies is carried out according to a similar scheme, which differs only in the use of an extension adapter, on which a collet clip is attached. They also use an additional backrest, which is adjustable when setting up the machine and serves as a support base for the collet.

The result of the research work was the following: the overwhelming effect of the beating of the ends of the casing on the beating of the center of the nozzle was established; It was proposed and successfully tested in the production of a more rational scheme of housing basing during final machining on machine tools with program control; the types are identified and the parameters of the distribution laws are calculated for the basic structural requirements of the assembled sets of special products.

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