STUDY OF FORCE DEPENDENCES IN DIAMOND IRONING

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Abstract: *The article considers the force dependences during diamond ironing at the beginning of movement with various mandrels, in contrast to a mandrel with a rigid structure: a pneumatic mandrel and a pneumatic mandrel on springs.*

Key words: *diamond ironing, pneumatic mandrel on springs, rigid mandrel, calibration, pneumatic mandrel, friction.*

ИССЛЕДОВАНИЕ СИЛОВЫХ ЗАВИСИМОСТЕЙ ПРИ АЛМАЗНОЙ ГЛАЖКЕ

Аннотация: *В статье рассмотрены силовые зависимости при алмазной утюжке в начале движения с различными оправками, в отличие от оправки с жесткой конструкцией: пневматической оправкой и пневматической оправкой на пружинах.*

Ключевые слова: *алмазное глажение, пневматическая оправка на пружинах, жесткая оправка, калибрование, пневматическая оправка, трение.*

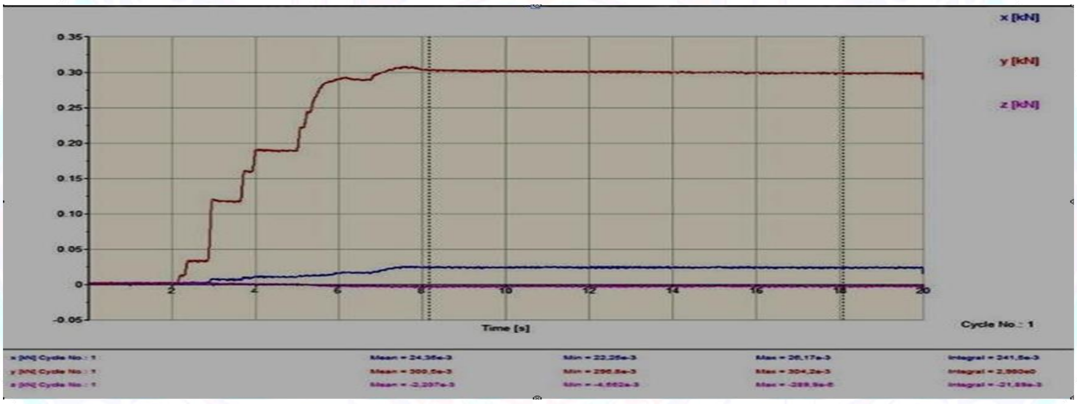
During diamond ironing of round profile parts, the ironing force can change and change direction when different mandrels are used. When the direction of the force changes, the friction against the surface changes, which affects tool wear. Diamond ironing can be carried out both from the beginning of the movement of the part, and during its movement.

As equipment for the experiment, we use a 1K62 screw-cutting lathe. For all experiments, a synthetic diamond indenter with a radius of R1.5 mm was used. For comparative experiments, a part of the rod made of 12X18H10T material was used for external processing. The part is installed in the centers of the machine. To avoid radial flapping, the outer surface of the part is machined. For internal processing, a part with a hole made of D16T material is used. Instead of a tool holder, a three-component

5233A1 dynamometer from the Kistler company was installed, and various mandrels with a diamond tip were fixed directly to it. The axis of the ironer must exactly coincide with the axis of the centers of the machine. Industrial oil I-20 is used for ironing with cutting fluid. In the process of diamond ironing on a lathe, two movements are distinguished: the rotation movement of the workpiece and the feed movement. All changes in forces will be recorded on the computer.

The design features of the pneumatic mandrel should provide a constant ironing force Ru even with a large swing surface, since the change in the volume of the bellows is small in relation to the volume of the receiver, therefore, the change in pressure in the bellows and the ironing force are also small.

Measurement with a three-component dynamometer, to determine the required pressing force, it is necessary to select the required pressure in the receiver. A screw forced through the ball limits the travel of the bellows. The air system is checked for air leaks.



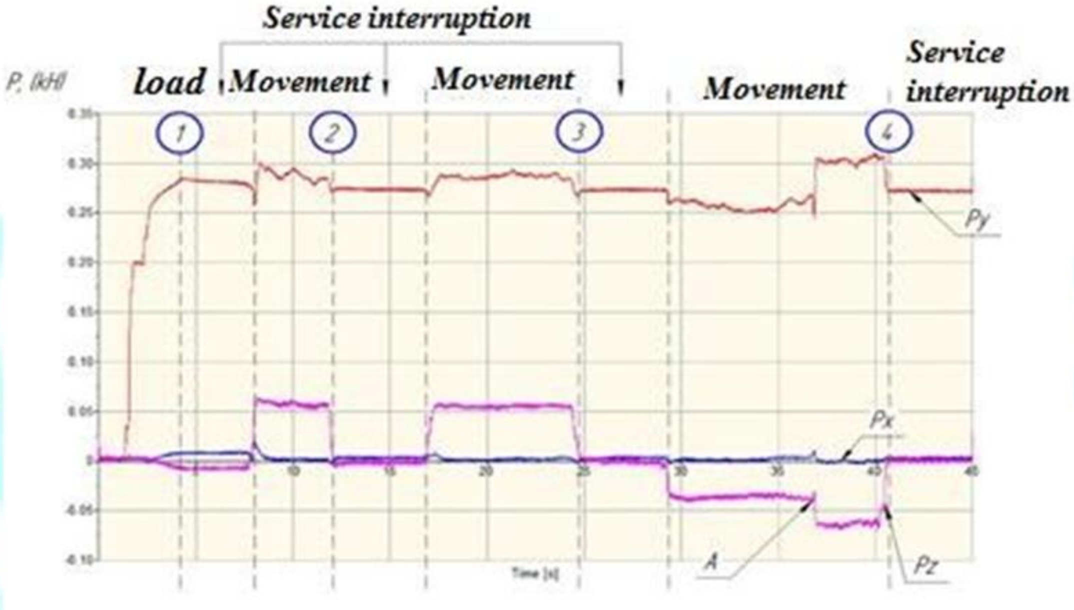
Rice. 1. Strength test schedule

The radial force Py decreases slightly with time due to the deflating of the pneumatic system. There was a change in the axial force Px, possibly due to the overhang of the tool relative to the dynamometer in Fig. 1.

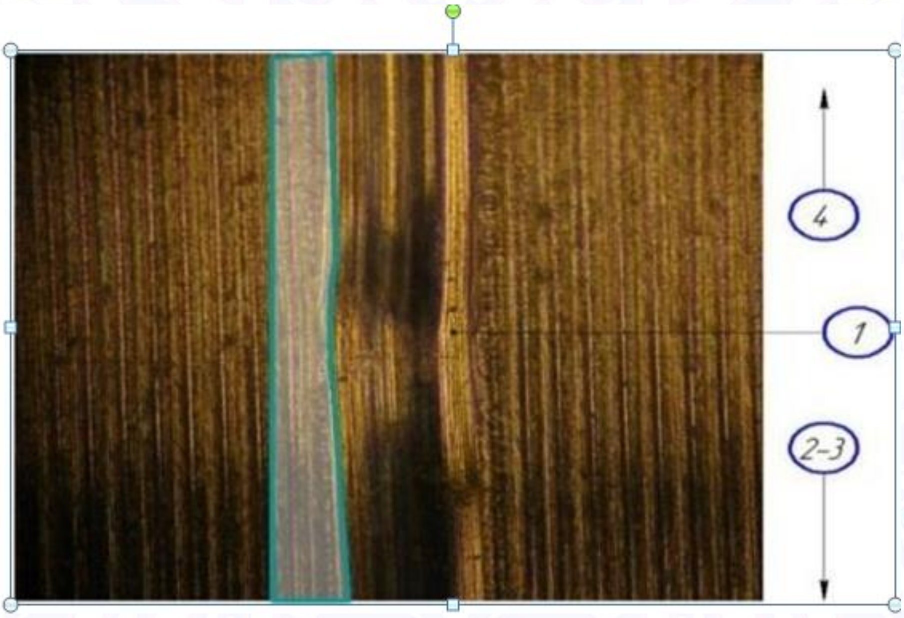
Force dependences of the ironing force at the beginning of a unidirectional movement are carried out in the same way as with a rigid mandrel.

As a result of studying the formation of cracks on a pneumatic mandrel, it was found that under force loading, the indenter often becomes warped.

The error is related to the design of the mandrel. No visual bending was observed as this could have happened inside the hull.



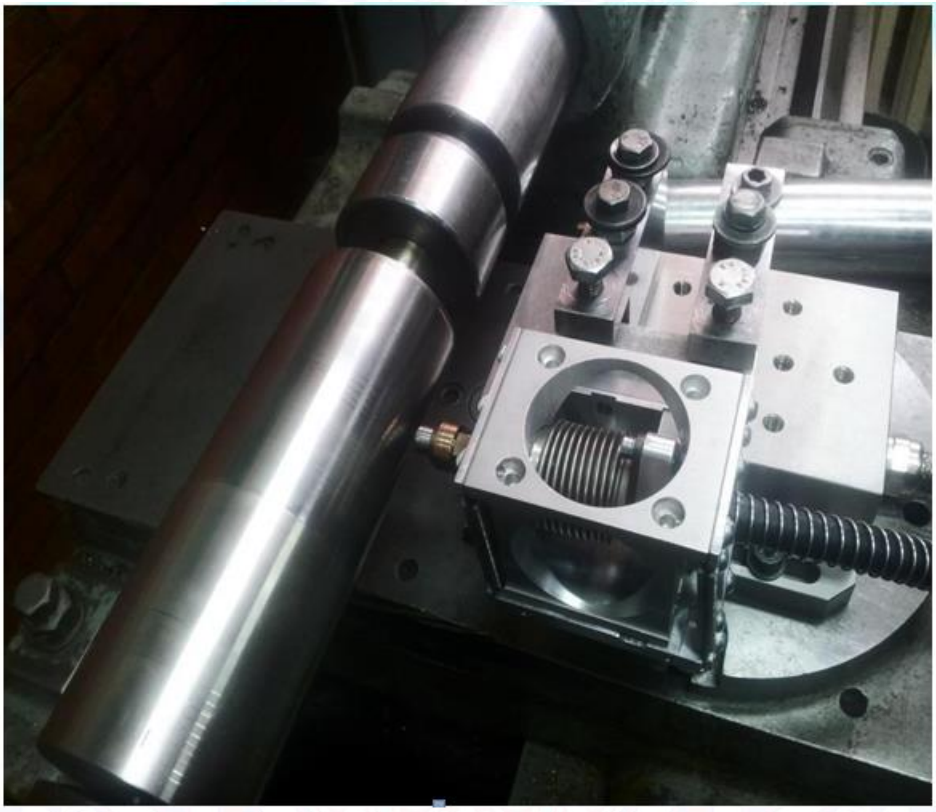
Rice. 2. Scheme of the reverse movement of the pneumatic valve during rotation



Rice. 3. Passing the injection point

On fig. 2 clearly shows the passage of injection site A. There is a change in the direction of the ironing force. You can also visually observe the passage of injection point 1 in Figure 3. In theory, there should be a constant pressing force on this mandrel, but structurally, due to the friction force, a change in the radial force occurs.

The design of the mandrel includes a diamond indenter fixed in the bushing, which, in turn, is rigidly fixed on a spring support. The spring support consists of four flat springs reinforced with plates to prevent spring deflection and contact of the movable part of the mandrel with its body. This support allows movement with a small amplitude around the starting point: ± 3 mm. The ironing force is provided by a hollow metal corrugation, i.e. pneumatic fur. Constant air pressure in the bellows provides a constant pressing force of the working body of the mandrel to the surface of the workpiece. Constant pressure is achieved by multiplying the volume of air in the receiver compared to the volume of air in the bellows, which makes it possible to avoid significant changes in air pressure in the bellows by compressing the bellows and reducing the volume of air. This should reduce the magnitude of the force element's force fluctuations compared to the magnitude of the force generated by it. To control the pressure in the system, a pressure gauge is installed on the receiver.



Rice. 4. Air spring mandrel installed on the machine with a receiver.

The deviation of the axial component of the force Px is a large overhang of the tool. According to the tangential component Pz, we can say that the axis of the indenter is below the axis of the centers of the machine.

The measurement of force dependences of the ironing force at the beginning of a unidirectional movement is carried out in the same way as with a rigid mandrel. Measurements are made according to the following criteria: in the direction of movement; at the degree of loading with forces of 100N, 200N and 300N; and the use of lubricants. All data and graphs are presented in Appendix A and Tables 19-22. Graphs are given for five times ironing. The coefficients of friction are given in table 2.5 where the load force is given as an approximation for the gradation, the exact force is shown in the graphs in the appendix.

The pneumatic spring mandrel allows ironing with a constant direction of the force vector. From the graphs it can be seen that the radial component of the force Py remains unchanged during the movement. The same happens with the friction force during the rotational movement of the tangential Pz and during the longitudinal movement of the support of the axial force Px. The graph shows a crack starting at the beginning of the movement. The change in the coefficient of friction from the ironing force is more uniform, but differs from the direction of movement.

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