

## RESEARCH ON THE TECHNOLOGY OF ROLLING IN OF ROTATING PARTS WITH ROLLERS

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**Abstract:** For the strengthening rolling of metal parts of rotation of larger diameters, when a high degree of plastic deformation requires a significant depth of its penetration, spherical or toroidal rollers are most widely used, and at larger angles of roller depression in the direction of its feed, waviness appears on the rolled surface of the part with a pitch different from the feed rate. Rolling is a method of finishing metals by pressure, in which a tool (rollers or balls) is pressed against the surface of a rotating part. This is not cutting, but plastic deformation of the surface layer.

**Key words :** rollers, running-in, stiffness.

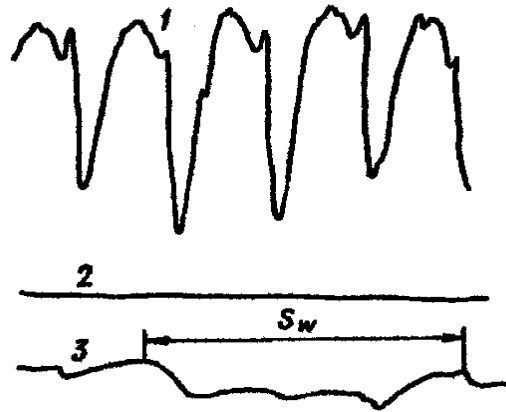
Rolling has its own characteristics for different shapes: for shafts (cylindrical surfaces) this is the simplest option. Rolling is carried out on lathes using roller or ball rolling mills fixed in the tool holder. For spherical parts (balls, fingers), the process requires special devices where the tool can copy the radius of the sphere. Often, two-roller devices are used that cover the sphere from two sides to balance the force.

This method is used for parts that work under high load or in friction pairs: crankshafts, hydraulic cylinder rods, ball bearings and bearing journals. In order to eliminate waviness proposed to stabilize the force on the roller rolling, which varies at each turn roller by alternating the sign of the efforts of the friction that arises from the radial runout roller. When you set a goal of using the combination of finishing and reinforcement rolling by eliminating the run-in undulation on the surface to develop technologies and devices for rolling rollers, taking into account stiffness machine-tool-item, in addition to propose and develop a device with a flexible needle rollers operating at small angles of indentation, which prevents the occurrence of the same run-in undulation on the surface.

We have proposed a method for eliminating waviness on the run-in surface by stabilizing the run-in force, which cyclically changes with each rotation of the roller due to the variable friction forces in the supports of the lever attachment with the run-in roller in the device housing. The run-in force is stabilized by replacing the sliding supports on which the lever is mounted with rolling bearings. The friction force in the lever supports is reduced by more than an order of magnitude, which leads to stabilization of the force on the run-in roller.

On the picture shows along these lines, the deformation of the metal of the surface layer of the part is greater than in the gaps between them, which causes the appearance of waviness. Expression is valid for the case that excludes the roller

slipping along the part during their mutual rotation, in the presence of slipping the actual wave pitch may differ significantly from the calculated one. By turning the roller axis around the perpendicular to the contact surface in one direction or another, you can change the degree of roller slipping and thereby affect the value of  $S_w$  (Fig. 1).



**Fig. 1 – Profilograms surface of the shaft:**  
**1 - to rolling ( $R_z = 100$  microns); 2 - after installing roller rolling site on ball bearings ( $R_a = 0,08-0,16$  m), 3 - after installing roller rolling site on the plain bearings ( $R_z = 16$  mm)**

Stabilizing by installing roller unit for rolling bearings rolling force  $P$ , we can eliminate the appearance of waviness at high angles of indentation, which are characteristic of the hardening even rolling. At the same time manage to get the surface roughness of  $R_a = 0,08-0,32$  m in the original  $R_z = 80-160$  m, in addition, to combine finishing and hardening rolling.

Presented in *Fig. 1* profilograms surface of the shaft of the most mild-steel 20,  $HB 140$  and after rolling with normal effort  $P_{un} = 5$  kN,  $S = 0,2$  mm / rev details,  $D_d = 117$  mm,  $D_p = 60$  mm, show the effectiveness of the installation site on the roller ball bearings. The curve 3 shows the incipient ripple on the surface of the run-in with a step of  $S_w = 3,9$  mm, which corresponds to  $S_w$ , calculated by the formula (1).

Rolling efficiency can be enhanced also by the use of rolls of small diameter (barrel-shaped and cylindrical), which completely eliminates the appearance of waviness and sliding the roller unit in the device due to the smallness of the angle  $\varphi_a$ .

One of the main components of the stiffness - the stiffness of the machine. In terms of preserving the optimal regime is a danger rolling less stiffness reduction as its volatility.

The elastic deformation of their constituent parts are a fraction of the deformation nodes. Our experiments shows the experimental dependence of the deformation of the radial force for three lathes of different sizes. At the beginning of unloading force drops sharply under very small displacements associated with elastic deformation of the parts without the involvement of the joints. At this point, the stiffness of the system is very high, it is measured in hundreds of kilonewtons per millimeter.

Let us suppose that the ratio of stiffness to the stiffness of the tool of other elements.

One of the ways to stabilize the radical rolling rollers is an exception to the overall stiffness of the technological system of the transverse stiffness of the machine. In the production of widely used Multi-Idler rollers rolling covering different types of devices. A rolling holes of great length would have been impossible without the use of Multi-Idler heads with a balanced radial pressure. When rolling sheeting or thin-walled parts of the stiffness must be taken into account.

Consider the strength of a system tool - detail by the example of rolling sleeves. We represent the bush in the process of rolling out a thin cylindrical shell simply supported at the ends and loaded in the middle section of the radial components of the effort, evenly spaced around the circumference and attached at the points of contact of the rollers. This case was considered in PP Beylarda.

Needed to stabilize the work force reduction rolling rigidity of the system is achieved by using technological tools with spring elements.

In experimens we shows a device with a springy one rollers housing for rolling shaft. An important advantage of this type of instruments lies in their simplicity. The required reduction in stiffness is achieved by changing only the configuration of the body without adding additional details. Resilient body is a cantilever, a circular beam of rectangular cross section. His deflection at the axis of the roller can be calculated based on the efforts rolling  $P$  and the geometric

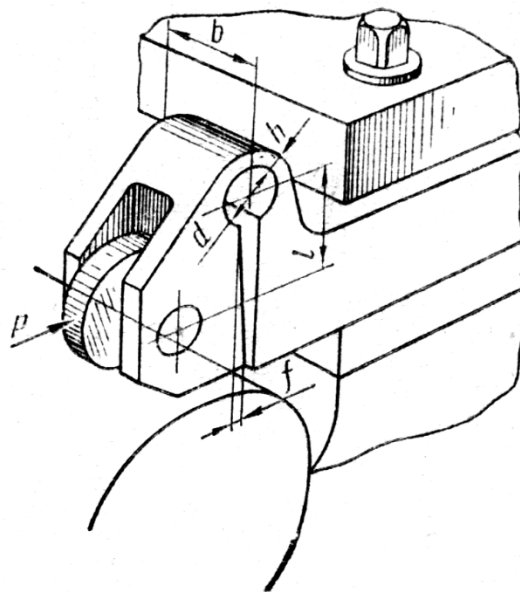


Fig. 2 – Universal one rollers device with springy body dimensions  $b, h, d, l$  (Fig. 2):

$$f = \frac{12}{E} \cdot \frac{P}{b} \left[ \frac{\pi \left( \frac{d}{h} + 1 \right)^3}{16} + \frac{l \left( \frac{d}{h} + 1 \right)^2}{h} + \frac{\pi \left( \frac{l}{h} \right)^2}{2} \cdot \left( \frac{d}{h} + 1 \right) \right], \quad (1)$$

where  $E$  - modulus of elasticity of the material.

The values of the coefficients  $c_f$  and  $c_p$  depending on,  $\frac{d}{h}$  and  $\frac{l}{h}$  given in *Table 1* there are shown and values  $k = F\left(\frac{d}{h}\right)$  needed to calculate the coefficients  $c_p$ .

Dependence  $\frac{P}{b} = F(f)$  for the cases with a thickness of springy  $h = 10$  mm in graphical form can be obtained from Fig. 8 are calculated for the yield stress  $\sigma_T = 1000$  MPa. Ray drawn from the origin to the point of intersection of the coordinates  $\frac{P}{b}$  and  $f$ , to determine the necessary size of the body. This problem can be solved in the design flow forming tools. For schedules of available devices make it possible to construct a geometrical dimensions of buildings characterizing their relationship (5), (6) and (7). In Fig. 3 plotted points that characterize the communication efforts with the deformation of the body size of  $h = 10$ ,  $d = 16$ ,  $l = 80$ ,  $b = 50$  mm. This case has been made of improved steel 34HN1M and tested on the press. The body loaded with a variety of efforts, with its deformation was measured. The estimated direct dependencies for this case - OA. Experimental curve drawn through the points of measurement of OM coincides with settlement in the area of elastic deformation, and it deviates from the right of point A, corresponding to the maximum allowable deflection - 3 mm. The body of this size are used to working with the device one rollers 7 kN force used on lathes with center height 200 - 300 mm, the rigidity of its 0,25 kN / mm.

If, in accordance with the data of *Table*. Adopt a rigid medium lathes with rolling of 10 kN / mm, then according to expression (4) for  $m = 0,25$  stiffness variations of the technological system will decrease by at least 5 times. Taking into account the operation of the system for unloading branch of the curve force - enough (see *Fig. 3*), we can expect even greater effect. A small run-out details, the error of its forms, and other violations of the baseline offset by the corresponding deformation displacements clip from minor fluctuations of the working force rolling within the elastic deformation of the product. In principle a similar construction heads, but with spring loading is used for rolling the axial channels in the crankshafts of diesel engines. The angles of the cones of support rings in these heads differ by  $2^\circ$ . This tells the balls in the process of additional rotation in the plane of the axial cross-section roll out the hole and increases the head life. The most widely used in practice have Multi-Idler Planetary device with conical rollers resting on a conical core. Tightness in the processing of parts Multi-Idler planetary instruments, ie difference between the diameters of the parts and the head of the rollers determines the effort rolling. High radial rigidity of the tool - the part and, as a consequence, the direct dependence of the surface quality of the tightness of small changes - a serious and difficult to combat lack of Multi-Idler Planetary devices. Although the constancy of the angle of rollers with a rectilinear generator creates them advantages over hard ball heads, the need for a trial run of parts in tight tolerances to maintain optimal tightness is a serious obstacle to their

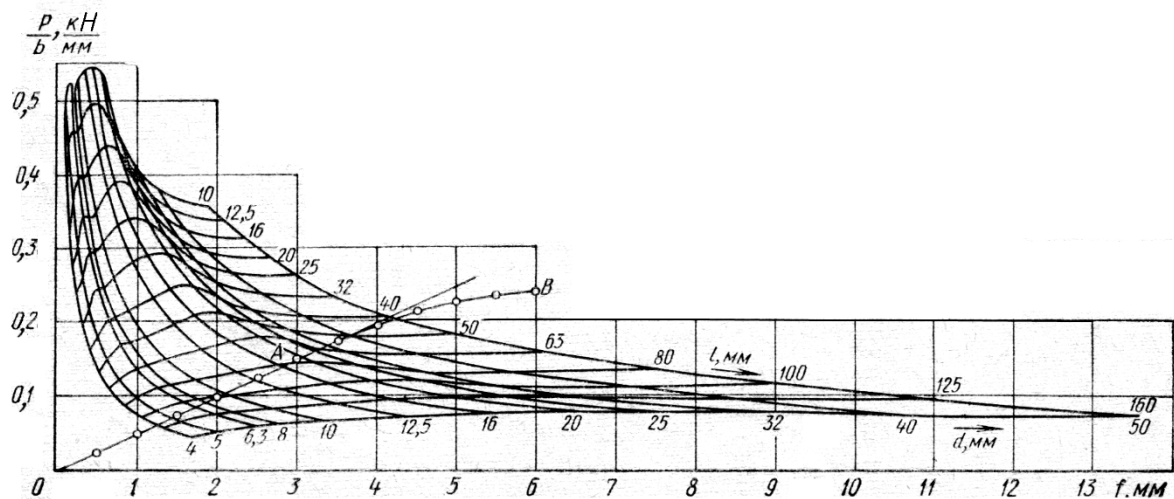


Fig. 3 – The dependence of the deflection force obkатыvaniya springy shells devices with a thickness of 10 mm springy

widespread use for machining of large diameter.

A technology and device for rolling non-rigid shafts with a spring element of the housing have been developed, a device with stabilization of the rolling force by replacing sliding supports with rolling supports, which made it possible to ensure uniform deformation of the metal of the surface layer and combine finishing and strengthening treatment of the surfaces of parts operating under conditions of wear and contact crushing. A device for rolling non-rigid bushings with flexible rollers has been developed. A patent of Ukraine has been obtained for the developed device.

#### List of sources used

1. Butakov B. Волнистость поверхности при обкатывании тел вращения роликами / В. Butakov // Motrol, Motoryzacja I energetykarnictwa. Lublin. – Vol15, No2., 2013 С. 15 – 22.
2. Zubiekhina-Khaiiat O.V. Research on the technology of rolling holes with needle rollers / O.V. Zubiekhina-Khaiiat / MATERIALS OF THE BLACK SEA REGIONAL SCIENTIFIC AND PRACTICAL CONFERENCE OF PROFESSIONAL AND TEACHING STAFF “DEVELOPMENT OF THE UKRAINIAN VILLAGE – THE BASIS OF AGRARIAN REFORM IN UKRAINE” April 17 - 19, 2019 - Mykolaiv, MNAU. 2019. P. 55 - 59.
3. Zubiekhina-Khaiiat O. RESERCH ON RIGIDITY OF THE SYSTEM «MACHINE TOOL-TOOL-DETAIL» WHEN RUNNING BY ROLLERS / O. Zubiekhina-Khaiiat // CERTIFICATE OF PARTICIPATION for participation in the IV International Scientific and Practical Conference Challenges in SCIENCE OF NOWADAYS, held on May 26-28, 2020. – Washington, USA – 2020.
4. Zubiekhina-Khaiiat O. RESERCH ON RIGIDITY OF THE SYSTEM «MACHINE TOOL-TOOL-DETAIL» WHEN RUNNING BY ROLLERS / O. Zubiekhina-Khaiiat // CERTIFICATE OF PARTICIPATION for participation in the IV International Scientific and Practical Conference Challenges in SCIENCE OF NOWADAYS, held on May 26 – 28, 2020. – Washington, USA – 2020.
5. Pat. 54685 Ukraine, MPK V24V 39/00. Device for impact finishing rolling of holes / B.I. Butakov, V.O. Artyukh, O.V. Zubiekhina; applicant and owner Butakov B. I. – No. u201003962; appl. 06.04.2010; publ. 25.11.2010, Bull. No. 22.
6. Patent of Ukraine for invention UA 101718 MPK V24V 39/04 (2006.01), B21H 3/00. Device for rolling large threads and Archimedean worms with rollers / B.I. Butakov, O.V. Zubiekhina; applicant and owner Butakov B.I. - appl. 07/18/2011, application number: a201108944; publ. 04/25/2013, Bull. No. 8.

**Анотація:** Для зміцнювального обкатування металевих деталей обертання більших діаметрів, коли високий ступінь пластичної деформації вимагає значної глибини її проникнення, найбільш широко використовуються сферичні або тороїдальні ролики, причому при більших кутах вдавлювання ролика в напрямку його подачі на поверхні, що обкатується, з'являється хвилястість з кроком, відмінним від швидкості подачі. Обкатування – це метод обробки металів тиском, при якому інструмент (ролики або кулі) притискається до поверхні деталі, що обертається. Це не різання, а пластична деформація поверхневого шару.

**Ключові слова:** ролики, обкатування, жорсткість.

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## **ОЦІНКА ЕКОНОМІЧНОЇ ЕФЕКТИВНОСТІ ВИРОЩУВАННЯ КУКУРУДЗИ ПРИ ЗАСТОСУВАННІ РІЗНИХ СИСТЕМ УДОБРЕННЯ І СТИМУЛЯТОРІВ РОСТУ**

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**Анотація:** Дослідження проводили у 2023–2025 рр. у господарстві ТОВ «НВА «Перлина Поділля», із застосуванням методів економічного та кореляційно-регресійного аналізу. Об'єктом були гібриди кукурудзи Піонер 8834 та ОЛТЕНІО, для яких вивчали вплив систем мінерального живлення: Поліфоска 8:24:24 (фон), КАС 150 і 300 кг/га та стимуляторів росту: Sterk BIO, AMINO.

Найбільш економічно ефективним є варіант із внесенням Поліфоска 8:24:24 + КАС (300 кг/га) у поєднанні з дворазовим застосуванням стимулятора росту AMINO (фази 3–4 та 7–8 листків). У структурі витрат переважають мінеральні добрива, паливно-енергетичні ресурси та засоби захисту рослин, тоді як витрати на стимулятори росту є незначними, але економічно виправданими.

Запровадження раціонально підібраних систем мінерального живлення та застосування стимуляторів росту, зокрема препарату AMINO, є економічно обґрунтованим способом підвищення ефективності виробництва зерна кукурудзи в сучасних умовах господарювання.

**Ключові слова:** економічна ефективність, гібриди кукурудзи на зерно, мінеральне живлення, регулятори росту, кореляційно-регресійний аналіз.

**Постановка проблеми.** У сучасних умовах розвитку аграрного сектору України кукурудза залишається однією з провідних культур, що має важливе економічне значення. Зростання вартості ресурсів і конкуренції на ринку зумовлює необхідність підвищення ефективності її виробництва [1].

Одним із ключових завдань є забезпечення оптимального співвідношення між урожайністю та витратами, оскільки значна їх частка припадає на мінеральні добрива, засоби захисту рослин і енергоресурси. У зв'язку з цим актуальним є вдосконалення систем удобрення та застосування стимуляторів росту, що дозволяє підвищити продуктивність без істотного зростання собівартості [2].