which has a direct influence on the residual force in the column gate studs after screwing the nuts tight and dropping the pressure in the hydraulic system. To determine the forces occurring in the studs during tightening, type 2PKB-10-100V resistance strain gauges were placed on them. The deformation of the studs was recorded by a TSTM-3 digital strain-gauge bridge. The device sustained hydraulic testing with a test pressure of 50 MPa.

The working tests of the device were made on a production column the parameters of which were inner diameter 1000 mm, operating pressure in the hydraulic system p=32 MPa, number of studs 16, and stud thread diameter W 164 x 1/4". The column had a double-taper packing ring with aluminum seals.

In the first loading of the column gate studs with the use of the tightening device, the coefficient of unloading (the ratio of the tensile force to the residual force in the studs) was 2. In subsequent loadings (second and third) the coefficient of unloading decreased, stabilizing at 1.45-1.50. The calculation value of the coefficient of unloading was 1.47.

During tests of the device with a 40-MPa pressure in the hydraulic system the tensile force on each stud was an average of 520 kN and the residual force in the stud after screwing the nuts tight and decreasing the pressure 365 kN. The calculation value of the force for tightening a single stud for the given gate is 335 kN.

After tightening the gate studs the column was subjected to pneumatic testing under a pressure of 38 MPa (working medium nitrogen). The column was under pressure for 2 days. No leakages of gas were observed in the primary joint. The tests showed that the device is effective and may be used for tightening high-pressure vessel studs. At the present time the device has been introduced in the Angarsk Petroleum Organic Synthesis Production Union.

The use of this device reduces the labor costs and the time for tightening (1 h instead of 8 with the use of the traditional methods and means for tightening) and provides the specified tightening force with uniform distribution of it over all the studs of the gate, which improves the tightness of the joint and increases the operating reliability of the apparatus as a whole.

FINISHING OF DISK TOOLS FOR ROLLING SPIRAL FINS ON TUBES

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Air-cooled apparatus for the petroleum refining and chemical industries uses finned tubes produced primarily by transverse spiral rolling and which are the main elements of the apparatus, determining its efficiency. Depending upon their purpose and service conditions, finned tubes may have different forms and dimensions.

Finned tubes are produced on KhPRT 12-28 mills with a set of rolling tools of built-up design consisting of individual deforming disks (Fig. 1). The dimensions of the working profiles of the disks have a variable thickness b, angle α, outer diameter D₀, and radius R. The blank for the finned tube is a double-layer material tube, the outer layer of AD1 aluminum and the inner of steel or brass.

In rolling, the metal of the blank is deformed as a result of radial and axial reduction of it by the rolling tool [1]. The formation of the fins is accompanied by intense flow of the aluminum tube metal between the rolling disks in the radial direction. One of the factors reducing the influence of external friction on the source of deformation is the working surface roughness of the rolling disks. A decrease in the roughness provides a decrease in the forces of friction and aids in radial deformation of the metal. This is especially important in rolling tubes with a high coefficient of finning.

At the All-Union Scientific-Research and Design Institute for Chemical and Petroleum Apparatus Building Technology, Volgograd, a special machine has been designed and built and investigations have been made to provide high quality of the tool working surfaces. The basis of the machine was a method (Fig. 2) of grinding the working profile of the disks with an abrasive belt simultaneously from two sides, which provides an increase in
Fig. 1. A disk of the built-up design rolling tool.

Fig. 2. Method of grinding the disk profiles with an abrasive belt: 1) part being ground; 2) abrasive belt; 3) clamp; 4) spring; 5) eccentric push rod; P) force for clamping the abrasive belt; s) amplitude of oscillations; l) eccentricity.

Fig. 3. Relationship of the thickness $\delta$ of the metal of the rolling disk being cut to the time $t$ of grinding it with an abrasive belt.

In productivity and balances the surface stresses. The abrasive belts are held to both sides of the profile of the rolling disk with a certain force $P$ and are fed to the working zone periodically by rotation of two gears by the base pitch of the rod of the pneumatic chamber, that is, after each cycle of grinding a part. In addition, the clamps supporting the abrasive belt provide oscillatory movement with a certain amplitude $s$.

Depending upon the rate of rotation of the part being ground and the frequency of oscillations of the holders with the abrasive belt, the trajectory of movement of an abrasive grain on the surface being ground will be different. The parameter characterizing the kinematics of the process is the angle of the network on the surface being ground [2]. A change in this angle makes it possible to control the direction of the microrelief.

The purpose of the investigation made was to determine the optimum direction of the microrelief and machine operating conditions providing obtaining of $Ra = 0.1 \mu m$ on the working profile of the rolling disks. The investigation was made on samples of 20Kh3MVF steel having the same original hardness and surface finish. The surface finish $Ra$ was measured on a model 253 profilometer.

During the experiments the relationship

$$y = f(x_1, x_2, x_3, x_4)$$

was investigated, where $y$ is the parameter of optimization of $Ra$, $x_1$ is the rate of rotation of the part being ground, $x_2$ is the force of clamping the abrasive belt to the surface being ground, $x_3$ is the grinding time, and $x_4$ is the grain size of the abrasive belt. For the solution of this multifactor problem, mathematical methods of experiment planning were used [3]. The levels of the factors were selected on the basis of a priori data [4] and preliminary experiments. The conditions of planning the tests are shown in Table 1.