The use of diamond smoothing as a final operation in the machining of parts made of electroslag remelted DI1 (20Kh15NZMA) steel has made it necessary to determine its effect on surface quality and the endurance of the material.

For the tests samples 10 mm in diameter (Fig. 1) were used. They were made from a hot rolled bar, the chemical composition and primary mechanical properties of which met the requirements of Ferrous Metallurgical Technical Specification 55-67 in the as-received condition. The sleeves for pressing on the sample were made of 9KhS steel. The hardness of the samples after heat treatment was HRC 30, ..., 32 and of the sleeves HRC 50, ..., 55.

The ground samples were smoothed with a diamond with a point in the form of a sphere with a radius of 2.5 mm in one pass at a speed of 30 m/min and a feed of 0.08 mm/revolution. "Industrial-20" oil was used as the lubricant.

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Fig. 2. The distribution of axial residual stresses in the surface layer of samples after grinding (1) and smoothing (2).

Fig. 3. Fatigue curves for samples at room temperature after grinding (1), smoothing (2), grinding with a press fit of the sleeve (3), smoothing with a press fit of the sleeve (4), and in a corrosive medium after grinding (5), and smoothing (6).

The normal force $P_y$ was first determined from the equation [1]

$$P_y = 2\pi R_{sph} h_{cor} B \varepsilon,$$

where $B = 135$ kg/mm$^2$, the true stress with $\varepsilon = 1$; $\varepsilon = 1.8$, the relative shear in compression; $c = 0.131$, the strain hardening index; $R_{sph} = 2.5$ mm, the radius of the diamond sphere; $h_{cor} = 0.011$ mm, the corrected value of the spherical segment.

The parameters $B$ and $c$ were established from experiments on the compression of 10 mm diam. cylindrical samples with internal grooves and reliable lubrication, as a result of which the appearance of a barrel shaped configuration was eliminated. According to Eq. (1) the smoothing force was equal to 25 kg. In smoothing the samples it was increased to 30 kg to obtain the greatest possible microhardness and depth of work hardening without damage to the material and surface. The holes in the sleeves were ground and polished. The edges between the internal surface and the face were rounded with a radius of 1 mm. Before pressing on to the sample they were heated to a temperature of 200°C. The interference fit was within limits of 20-25 $\mu$, which corresponds to a fit of $10 Pr^2 = 10^{-6.025}$. The unit contact pressure in the joint was within limits of 10.5-13 kg/mm$^2$.

In the investigation the surface, roughness, the character of the microrelief, the work hardening, and the axial residual stresses were determined. The corrected radius of curvature of the bottom of the depressions $\rho$, which characterizes the surface microrelief, was found from profilograms. The work hardening was studied by measuring the microhardness on the surface with successive removal of thin layers of metal by electrolytic polishing. The microhardness was measured on a PMT-3 tester with a load of 100 kg. The surface near the measurements corresponded to class 10 without etching along the grain boundaries, which was done by selection of the electrolyte and the method of electropolishing.

The residual stresses were determined mechanically on a PION-2 unit.

The data obtained on roughness and work hardening is shown in Table 1 and the axial residual stresses are shown in Fig. 2.

The data in Table 1 shows that smoothing, done after grinding, improves the surface finish by two classes. The microrelief formed differs in a positive manner from that before. There are no sharp peaks on the projections and there was a substantial increase in the corrected radius of curvature of the bottom of the depressions.