The piercing mill of the Pilger Rolling Mill of the Il'ch Plant is intended for piercing 300-450-mm-diameter round ingots and billets of carbon and alloy steels. Its technical characteristics are as follows: maximum diameter of work rolls 670 mm, barrel length 927 mm, angle of feed of the rolls 4°30', power of electric motor of main drive 2200 kW, and number of revolutions 31-37 rpm. The work rolls of the double-cone roll pass design are made of steel 55 and hard-faced with PP3Kh2V8 powdered welding electrodes.

During operation we studied the character of wear over the length of the roll barrel and its absolute magnitude. Wear of the working surface of the rolls leads to optimization of the profile, which permits a well-founded development of the roll pass design of the roll. The character of wear of the work rolls of the existing design showed that

Fig. 1. Existing design and character of wear of work rolls.

Fig. 2. Improved design and character of wear of work rolls.
the profile approximates to a single-step design (Fig. 1). The change of the conditions of deformation and consequently of the specific forces of the pressure over the length of the seat of deformation and character of wear of the working surface of the roll can be divided into three main zones. The first zone is uniform wear in the first piercing cone, the second zone is considerable nonuniform wear in the second piercing cone and partially in the constriction, and the third zone is nonuniform wear in the second reeling cone.

The uniform wear in the first zone can be explained by intense and uniform deformation upon contact and advance of the ingot until it encounters the mandrel; the nonuniform wear in the second zone can be explained by the conditions of secondary contact, start of reduction on the mandrel, and, in connection with this, considerable ovalization of the ingot, and the nonuniform wear in the second zone of the reeling cone can be attributed to the increase of the outside diameter of the hollow shell.

On the basis of the character of wear of the working surface of the roll we developed an improved single-step design (Fig. 2). The work rolls without hard facing were made of steel 50KhN with hardness HB 285 and tensile strength 70 kg/mm²; they operated 20 days. An analysis showed that the primary conditions of contact improved, slipping was absent during secondary contact, and the load on the electric motor of the main drive decreased. Wear of the surface of the new work rolls is uniform and lasts the entire campaign of their operation.

For an evaluation and comparison of the magnitude of wear of the rolls having the existing and new pass designs we studied the indices of wear resistance and life of the work rolls. As the index of the wear resistance of the rolls, A, we used the ratio of the quantity of rolled metal G to the average depth of surface wear Δ:

\[ A = \frac{G}{\Delta \text{ tm}}. \]

In the case of rolling, on the hard-faced rolls of the existing design the average index of wear resistance for the right roll was 7150 tons/mm and for the left 7630 tons/mm. On the rolls of the improved design without hard facing this index was, respectively, 2285 and 2532 tons/mm, i.e., the wear resistance of the left roll in both cases was higher. This can be explained by the circumstance that during piercing the scale falls between the right roll and metal, increasing the friction coefficient, whereas when the metal contacts the left roll the scale falls down. The index of wear resistance is about three times higher in the case of rolling on the rolls with the improved design.

Tables 1 and 2 present comparative data which confirm the improvement of the qualitative indexes during rolling of tubes in rolls with the improved design. Sampling of seconds showed that the number of tubes with inside scabs decreased from 2.3 to 1.3%, i.e., by about 1.8 times, and with a difference of gauge from 0.26 to 0.13%, i.e., by twofold. On the whole, the number of second-grade tubes decreased from 3.6 to 2.9%, and rejects from 0.28 to 0.25%. In connection with the fact that the main causes of the production of second-grade tubes and rejects are the quality of the initial billet, technology of rolling, and pass design of the roll, the improvement of tube quality in the presence of the same first two parameters is explained by the use of rolls of the improved design.

During rolling in rolls with the existing pass design the operating conditions of the mandrels of the piercing mill are different (the conical mandrel with a ratio of length to diameter of 1.4–2.4 is made from a cast billet