THE PROPERTIES OF QUENCHED HIGH-SPEED STEEL 
AFTER BRIEF HEATING DURING TEMPERING

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In heat treating tools of high-speed steel the operation that takes the longest time is tempering of the tool after quenching. It is conducted at 560-580° two or three times, with holding for 1 h, and cooling in air to room temperature between temperings. Under plant conditions the cooling process lasts 3-5 h after each tempering.

To automate the heat treatment a brief heat treatment has been developed for tools of high-speed steel [1, 2] at a higher temperature. Triple tempering at 560° with holding for 1 h has been replaced by double tempering at 600° with holding for 10 min. This treatment is used for drills in automatic heat treatment lines of tool plants.

The tools tempered by this method are not inferior to those produced by the standard treatment.

We investigated the change in the properties of quenched steels R6M3 and R18 resulting from brief heating.

Samples of steels R6M3 and R18 were quenched from 1225 and 1280° respectively, with heating in salt baths and cooling in oil, and tempered two or three times at 540, 550, 560, 580, and 600°, with holding for 15 sec to 1 h.

Fig. 1. Change in the properties of quenched steel R18 after tempering at 560° (a, b), 580° (c), and 600° (d). O) Single tempering; ) double tempering; X) triple tempering.
From Fig. 1 and Table 1 it can be seen that brief heating of quenched high-speed steels at the temperatures given substantially lowers the hardness – from HRC 63-64 in the quenched condition to HRC 58-59 following tempering for 15 sec.

At short holding times, corresponding to the minimal hardness, the amount of retained austenite remains unchanged and the strength and plasticity of steel R18 almost double as compared with the quenched condition.

This property of high-speed steel can be utilized in manual straightening of rod-shaped tools in the quenched condition if brief heating of the tools to 600° in a slat or high-frequency inductor is used instead of the gas heating presently used.

Brief heating does not stabilize the retained austenite in the quenched high-speed steel.

The lowering of the hardness after brief heating of quenched high-speed steel at 560-600° (Fig. 2) is similar to the well-known drop of the hardness [3, 4] after tempering at 250-400° for 1 h. According to [4], the drop in hardness is due to finely dispersed carbides of the cementite type and their coalescence. The difference is that these processes occur considerably more rapidly at standard tempering temperatures of 560, 580, and 600°.

The secondary hardness, particularly of R6M3, increases more intensely after tempering at 600°, reaching HRC 64 with holding for 3-20 min, although this hardness is below the maximum. Therefore the change in hardness is inadequate as a criterion for selecting the conditions of brief tempering.

The completeness of the martensitic transformation during tempering of R6M3 was investigated with an Akulov torque magnetometer.