Proper use of high-speed steels and further improvement of the composition and properties are important goals. In recent years tungsten-molybdenum steel R6M5 has come into wider use. Molybdenum and tungsten, which are chemical analogs, have almost identical effects on transformations in high-speed steels. The difference is that molybdenum lowers the temperature of the transformation occurring during primary crystallization, hot deformation, and heat treatment.

At deformation temperatures from 1075-1100 to 875-900°C the ductility of steel R6M5 is higher than that of tungsten steel R18. As for all high-speed steels, the steel is cooled slowly after forging. The steel must be cooled in air to 25-40°C, which reduces the danger of cracking and splitting of the blanks (particularly large pieces).

The annealing temperature for steel R6M5 must be somewhat lower (830-850°C) than for steel R18 (860-880°C). Annealing produces a fairly low hardness of HB 228-255. For tungsten-molybdenum high-speed steels it is necessary to establish the upper and lower limits of the permissible hardness. If the total is too soft (< HB 228) then galling occurs during cutting, which puts cutting tools out of commission very rapidly.

Molybdenum has a substantial effect on sensitivity to decarburizing, particularly at concentrations around 5%. An effective means of preventing decarburizing is the use of magnesium fluoride or borax for rectification (deoxygenation) of salt baths. To remove the decarburized layer formed in rolling it is necessary to increase the allowance 10-15% as compared with that for tungsten high-speed steels.

The quenching temperature for tungsten-molybdenum steels is lower, and therefore the holding time must be increased for complete solution of carbides and saturation of the solid solution. Our observations indicate (as was stated in [1]) that the final heating time in the bath must be increased by 25-30%. Under these conditions the best quenching range for steel R6M5 is 1220-1240°C.*

*For long tools this temperature should be reduced by 10-15°C.
This produces a fine grain size, grade 11-10. The cooling conditions for steel R6M5 are the same as for standard high-speed steels.

The tempering temperature is of considerable importance. Our studies indicate that the low point of the hardness is reached at a tempering temperature around 350° for steel R6M5, as for tungsten steels (Fig. 1). The hardness decreases to HRC 59-59.5. The hardness of steel R6M5 was highest after tempering at 540-550°, and that of steel R18 after tempering at 560-570°.

To increase the toughness of steel R18 it is recommended [2] that the first tempering temperature be lowered from 560-570° to about 350°. This recommendation was checked for steel R6M5. Double tempering was conducted at 540 and 560°. The secondary hardness in relation to the tempering conditions is given in Table 1.

The lower hardness of steel R6M5 subjected to treatment 3 is due to the fact that the carbides, which contain molybdenum and precipitate during tempering, have a high tendency to coalesce.

The higher hardness obtained by lowering the first tempering temperature to 350° is explained by the fact that the cementite crystals precipitated at this temperature are more evenly distributed in the steel. In turn, this favors more even precipitation and distribution of special carbides during subsequent tempering at higher temperatures.

The physical properties of steel R6M5 after quenching and tempering (Fig. 2) are approximately the same as for steel R18. At a tempering temperature of 350° the coercive force reaches a peak, which indicates precipitation of dispersed cementite particles.

The variation of the amount of retained austenite with the tempering temperature after quenching from 130° is given in Table 2.