Structural x-ray analysis showed that HTMS helps the formation of a fine, homogeneous structure characterized by a stable dislocation system and by a lower level of microdistortions inside the mosaic blocks, limited by the dislocation walls.

Phase analysis showed that the structure of carburized free-cutting steel after HTMS treatment consists of martensite, austenite, and M₆C₃-type carbides. Analysis of the diffraction line (511) intensities of the carbide phase showed that, after CTMS, the surface layer contains 50-60% more carbides than in noncarburized, profile-rolling steels.

Residual austenite content in the carburized layer depends on the carbon content of that layer. After quenching from 1200°C that content is 60%. After the triple tempering at 560°C followed by chilling, the residual austenite content decreases to 16%.

However, even at this residual austenite content, the combined action of CTT (chemico-thermal treatment), HTMS, and HHDE ensures not only recuperation of properties lost during the deep carburization process, but also considerably improves them.

Industrial experiments were performed on cutting tools manufactured using the procedure of high-temperature carburization of a 3.4-mm-thick layer + HHDE combined with HTMS with deformation degree 0.72 + annealing + quenching + triple tempering + subzero treatment. It was found that tools manufactured from rolled profiles using this procedure were 2-3 times more wear-resistant than tools manufactured using the standard method.

The method described here for manufacture and treatment of cutting tools is not complicated and can be performed using standard equipment. This method is already industrially accepted. Economic benefits from industrial use of this new method accounted for 24,400 rubles per year for the 40,000-50,000 cutting tools produced.

LITERATURE CITED

NATURE OF SOUNDABILITY FOR LARGE FORGINGS WITH VARYING MICROSTRUCTURE THROUGH THE CROSS SECTION

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Different forms of results are observed in the practical use of ultrasonic monitoring (USM) for large forgings [1].

The most typical of these are as follows:
1. Absence of pulses through the cross section of forgings with diameter up to 900 mm with four or more bottom echo-signals (BES) (Fig. 1a).
2. Presence of a stable pulse from the axial zone of the forging with BES ≤ 4 (Fig. 1b).
3. Presence of individual pulses from a zone around the forging axis with 2-3 BES (Fig. 1c).
4. Pulses from zones of different radius around the axis with BES ≤ 2 (Fig. 1d).
5. A large number of pulses from the zone around the axis with BES = 1-2 (Fig. 1d).
6. A large number of pulses from various depths below the surface of the casting with complete absence of BES (Fig. 1e).

In the first three cases soundability is considered to be good, and the structure is considered to be defect free in the first case, with an axial defect in the second, and defective around the axial zone in the third.

In the fourth and fifth cases, forgings are considered to have bad soundability, and in the sixth they are considered to be unsoundable [1].

In the first two cases, results of USM may be interpreted with sufficient reliability for practical purposes. It is not possible in the rest of the cases to establish the true nature of defects without additional monitoring of microstructure in templates cut from the area of USM.

In view of this, Bauman grey prints were taken* from templates, then after hot etching templates were examined visually.

"Grey whiskers" are observed in each template. In large forgings actual defects are located primarily in grey whiskers [2], and therefore areas of grey whiskers were subjected to careful examination.

In the majority of cases USM "apparent defects" proved to be false with macrostructural monitoring of templates.

With the aim of investigating USM pulses further additional microstructural studies were carried out for each template, particularly carefully in areas of apparent defects.

It can be seen from Fig. 1 that USM results depend on microstructure in the forging cross section.

CONCLUSIONS

1. Results of USM are governed both by the location of actual defects and by microstructure through the forging cross section.

2. Pulses observed from the remains of boundaries in overheated structure [1] and a simultaneous reduction in the number BES are apparently caused by a change in the angle of reflection of untrasonic (US) waves at the pearlite-ferrite boundary with partial energy dissipation [3].

3. "Grey whiskers" observed in each forging without obvious defects are differentiated with sufficient reliability from actual defects by controlling the power of the ultrasonic signal and receiver sensitivity for the US defectoscope under conditions when the remains of overheated structure boundaries are absent from the microstructure.

*A. P. Volkova and T. N. Tukshumskaya took part in this work.