A change in the thickness of sheets from 5 to 20 mm does not affect the fatigue strength of AMg6 alloy.

Cyclic overloading produces practically no effect on the tensile strength. Consequently the $\frac{\sigma_s}{\sigma_b}$ ratio increases considerably in the fatigue process.

During exposure to alternating tension (5 million cycles) with the maximum stress equal to the endurance limit no alteration of the initial mechanical properties was to be registered in any samples of the investigated series.

The influence of the stress concentration during exposure of alloy AMg6 to repeated application of load drops sharply with growing overload, and becomes almost unnoticeable when overloading by a factor of 1.45-1.50. Apparently, the plastic strain developing at the sites of stress concentration levels off the stress peaks and leads to a reduction of the metal's sensitivity to the action of stress concentrators.

As it was shown by the investigation, the degree of cyclic overloading during application of alternating tension and compression stresses may be judged by the appearance of the fatigue fracture and by a comparison of the areas of the brittle and plastic failure zones in the fracture.

THE FINE STRUCTURE AND THE WEAR RESISTANCE OF MACHINE PARTS

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Papers [1] - [3] were devoted to determinations of microscopic stresses, the sizes of mosaic blocks, and the phase composition of the thin surface layer resulting from the friction of hardened rollers simulating the performance of toothed wheels. It was interesting to investigate the problems related to the changes in the fine structure at the frictional surface of steel gears, as well as those arising in the wear process in cast irons.

Investigation of Tractor DT-54 Gear Teeth. Gears made from steel 18KhGT were subjected to gas carburizing at 920-930° for a period of 16 hours (depth of layer: 1.3-1.8 mm), water- and oil-quenched from 870°, and tempered at 220° for 1.5 hours. The microstructure of the teeth surface consisted of fine acicular martensite with evenly distributed globules of carbides (HRC 58-59).

Pitting was found to occur in consequence of teeth wear. X-ray pictures were taken of sections of the tooth profile; the metal was also studied under the microscope. Parallel measurements were made of the microhardness at the surface and in the inner layers.

Iron radiation (tube BSV) was used; voltage: 45 kV, plate current: 14 mA.

The parts were placed in a special chamber [2]. The 0.14-mm slit enabled narrow lines to be produced even for hardened steels. The exposure was 1.5-2 hours. The tooth core tempered for one hour at 600° served as a standard to produce the characteristic curve.

The magnitude of the residual stresses and the block sizes were determined from the shape of the diffraction curves by the method of harmonic analysis [4].

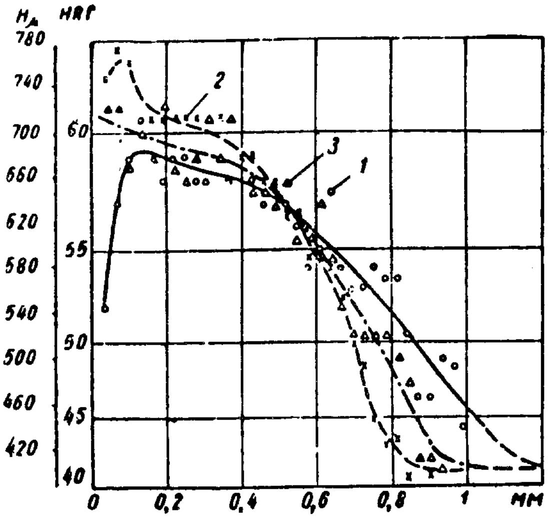
It was established that the sharpness of the lines is related not only to the presence of internal stresses, but also to the variation in the size of crystallites.

The methods used in isolating the dispersity A_t^u effects from those of distortions A_t^g, and for determining the average sizes of the mosaic blocks, the r.m.s. displacements $\sqrt{L^2}$, and relative deformations, are described in detail in paper [1].

The phase composition of the steel in different parts of the roller profile was determined by parallel X-ray analysis. Data on the variation of the microscopic

TABLE 1

Tooth No.	Degree of wear	Location filmed	σ in kg/mm^2	Dx10^{-6} in cm.	Austenite contents, %
379	Unused	Pitch-point	112	9	—
1—1	Strongly worn out tooth, pitted at the root	Tip,	71	8	5
		Pitch-point	86	5	8
		Root	90	9	8—12
	Unused	Top	120	5	6
129—2	Strongly abraded pitted at the root	Root	93	3,5	—
		Root	82	7	—
15	Worn out	Root	93	5,5	—



Depth of measurement

Fig. 1. Microhardness variation in different sections of the tooth profile: 1 - tip, 2 - pitch-point zone, 3 - root.

stresses, mosaic block sizes, and the phase composition in different parts of the gear tooth profile will be found in Table 1.

Investigations have shown that the fine structure in the surface layer changes with progressive wear, but differently for different parts of the tooth profile. The stresses at the root of an abraded tooth are higher than at the tip, but at the same time they are inferior to the stresses at the surface of a tooth that has not been subjected to friction. The highest proportion of austenite is observable in the root of tooth 1-1 at the spot affected by pitting.

Microhardness measurements were made with a PMT-3 tester under 100-g load. To prevent the edges of the section from clogging up the investigated gear tooth was coated with an alloy. Microhardness was determined at the tip, the root, and the pitch-point zone of the tooth in the places where X-ray patterns were taken, at a distance of 30 microns from the working surface and along the depth of the carburized layer (Fig. 1). The microhardness value of a new tooth after heat-treatment, measured at the same distance from the surface, amounted to H_μ = 657 kg/mm^2 after exposure to 100-g loading.

Investigations revealed that in the process of tooth wear microhardness in different sections of the tooth profile changes unevenly. The highest value is found at the tooth root in the spot attacked by pitting - $H\mu$ = 760 kg/mm^2, and at the pitch point - $H\mu$ = 734 kg/mm^2. The lowest microhardness value is observable at the tooth tip - $H\mu$ = = 540 kg/mm^2. Along the tooth profile section the microhardness values - show an uneven drop. In certain sections they are higher than in the neighboring ones. The variation of microhardness showed that the active working layers of the surface are being subjected to complex plastic strains which vary at different points of the tooth profile.

In the process of wear the tooth tip undergoes tempering. The microhardness in the tooth tip drops to $H\mu$540 kg/mm^2, the microscopic stresses - to 71 kg/mm^2. At the root of the tooth there appears a poorly etching light-colored layer (Fig. 2) consisting of structureless martensite with a certain proportion of residual austenite (10-12%). The microhardness of the light layer amounts to $H\mu$ 760 kg/mm^2, the microstresses attain the value of 90 kg/mm^2. Microscopic fissures extending in depth from the metal surface in the direction of the displacement of the contact points were revealed in this layer (Fig. 3). Particles of metal separate along these cracks forming pitting cavities (Fig. 4). The presence of the light layer leads to premature pitting.

Investigation of the Wear of Shot-Peening Machine Blades. A comparative study was made of the thin crystalline structure in the surface layer of blades with different chemical composition. To increase wear resistance the blades were cast from chromium pig iron with additions of titanium and boron (Table 2).

The blades were tested for wear resistance in a KhTZ-model machine. The objective of this investigation was to establish the possibility of determining the microstresses and the mosaic block sizes depending on the chemical composition of the metal.

The blades were quenched from 900° in oil and subjected to a 1.5-hour temper at 200°.

The microstructure of blades 7, 15, and 16 made from chromium cast iron consisted of martensite with dispersed

Fig. 2. The light-coolor layer at the tooth of a steel 18KhGT gear. x 400.

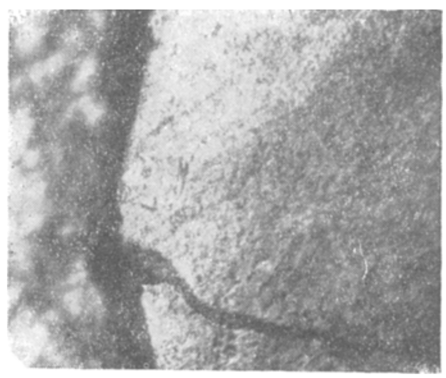


Fig. 3. Formation of cracks in the white layer in the root section of the tooth made from steel 18KhGT. x400.

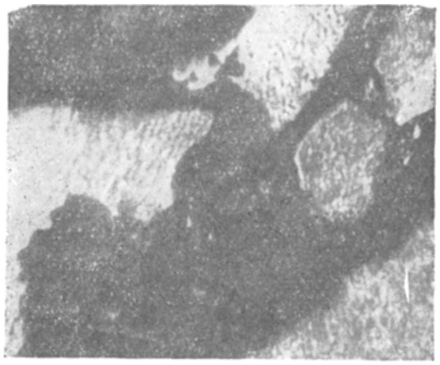


Fig. 4. Pitting cavities formed as the white layer separates from the root of a steel 18KhGT tooth. x400.

carbides and a small quantity of undecomposed austenite. The microstructure of blade 1 consisted of pearlite with graphite platelets. The blade hardness values after thermal treatment and exposure to wear are given in Table 3.

The investigation has shown that after exposure to the same type of heat treatment the formation of the thin crystalline structure in the blades depends on the chemical composition of the cast iron. As may be seen from Table 3 the least abraded blade 16 (0.13 g) has the highest microstresses σ 112 kg/mm^2, and the smallest size of blocks $6 \cdot 10^{-6}$ cm.

The greatest wear was manifested by the grey-iron blades. In this case the surface microstresses amounted to 77 kg/mm^2, while the block size was by one order of magnitude higher ($4 \cdot 10^{-5}$) than in blade 16.

TABLE 2

Blade No.	Pig-iron chemical composition in %					
	C	Cr	Ti	B	Mn	Si
7	2,10	4,63	2,60	0,31	0,75	2,32
10	2,05	4,21	2,69	0,60	0,78	2,39
16	1,82	4,33	3,46	—	0,81	2,15
1*	3,70	0,23	—	—	0,71	2,4

*Blade 1 was made from gray iron.

TABLE 3

Blade No.	Hardness HRC		Weight loss after 2-h wear in g.	σ in kg/mm^2	$D \times 10^{-6}$ in cm.
	After heat treatment	After wear exposure			
7	57	57	0,35	77	18
15	57--58	57	0,50	86	9
16	60	58	0,13	112	6
1	20	19	2,10	66	40

CONCLUSIONS

1. The wear of metal by friction is accompanied by a variation of microstresses, mosaic block sizes, the phase composition, microstructure and microhardness.

2. At the first stages of friction the stresses decrease, then they rise again under the influence of the secondary thermal processes but fail to attain the initial values.

3. In the frictional process a poorly-etching brittle white layer forms at the root of the tooth. This layer contributes to the appearance and development of pitting.

4. It appears that one of the reasons for the low wear resistance and the premature formation of pitting in the teeth of gear 37-438 is to be attributed to the high initial stresses which arise in the gears as a result of exposure to the water and oil quench. To improve the wear resistance it is recommended that the gears be quenched in oil.

5. The formation of thin crystalline structure (microstresses, mosaic block sizes) after the same type of heat treatment depends on the chemical composition of the cast iron.

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