Variation of Elastic Constants of Hardened 1 per cent Carbon Steels on Tempering

It was shown some years ago that changes in elastic constants accompany the hardening process in steel[1] and can be measured by ultrasonic techniques. More detailed experiments have been made recently on two commercial steels containing about 1 per cent carbon. The steels were quenched in oil from 780° C. and then tempered for one hour at temperatures between 100° C. and 650° C., in steps of 50° C. Young's modulus, E, and the rigidity modulus, G, were measured after each heat treatment by the ultrasonic-pulse method. The rigidity modulus was also measured by static loading, the same specimens being used.

The specimens were 7 in. long and 0·5 in. in diameter with enlarged ends of square section for the application of the static torque. The square ends were used for the ultrasonic tests in which the phase velocities for pulses in the longitudinal and transverse modes were measured. The values of E determined from these velocities are estimated to be accurate to within ± 0·2 per cent and those for G to be within ± 0·1 per cent.

The static values of G were measured in a special rig designed to apply a pure torque and the maximum shear stress did not exceed 4,000 lb./in.². The twist was measured over a length of 3 in. by means of two mirrors which were observed simultaneously with an autocollimator. The static values of G are considered to be accurate to within ± 0·3 per cent.

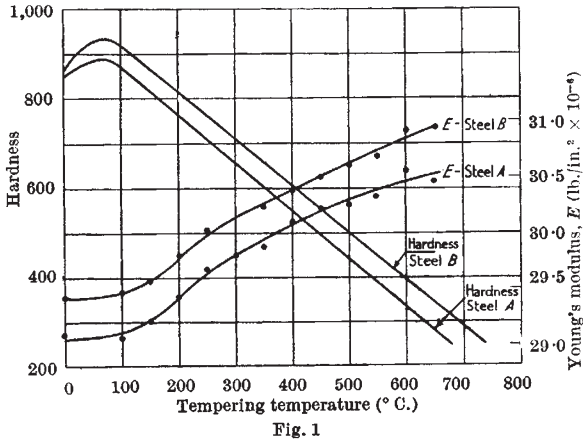

Fig. 1

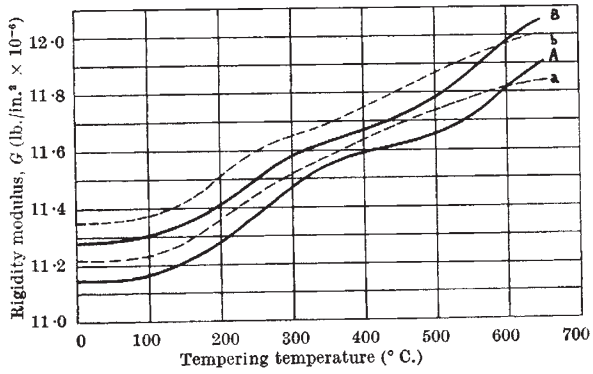

Fig. 2. Rigidity modulus vs. temperature of tempering. For steel A: (a) by the ultrasonic method, (A) by the static method; and for steel B: (b) by the ultrasonic method, (B) by the static method

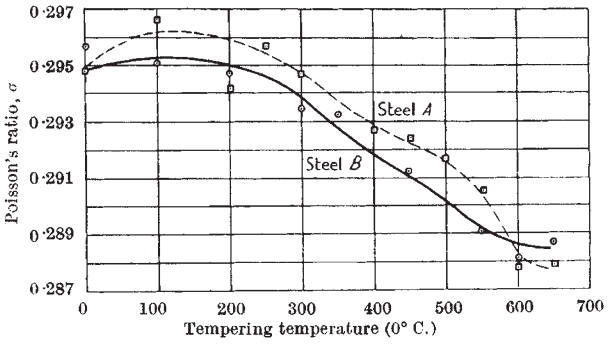

Fig. 3

Fig. 1 shows the ultrasonic values of E for the two steels as a function of tempering temperature, the corresponding values of the hardness being also plotted. Fig. 2 shows the values of G determined by ultrasonic and static methods, again as a function of tempering temperature. In Fig. 3 the values of Poisson's ratio derived from the ultrasonic figures are given. It can be seen that the total increase from the hardened to the fully tempered state is about 4·5 per cent for E and 6 per cent for G.

The static values of G are about 1 per cent lower than the ultrasonic values for hardened steel for tempering temperatures up to 450° C. At higher tempering temperatures the difference is insignificant.

A possible explanation is based on the supposition that the bars were not fully quenched through their thickness. If the surface were harder it would have more effect on the static measurements because of the stress gradient, whereas the ultrasonic tests are based on the average wave velocities in a radial direction. Further work would be needed to prove the validity of this effect.

This work has been carried out as part of the research programme of the National Physical Laboratory and is published by permission of the Director.

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[1] *Engineer*, **191**, 318 (1951).

A Surface Electroluminescence Effect in Diamonds

Ten diamonds, all of type I, have been found to luminesce with bright green spots of light when a potential difference is applied to them. The luminescence is often intense enough to be seen in daylight. This effect was first noticed while investigating some aspects of the counting properties of the diamonds, and only after the diamond had been coated with a thin layer of graphite and annealed in this condition.

All the stones so far tested are of the conventional rhombohedral form and with a maximum dimension of about 1 mm. Before being coated with 'Aquadag', the diamonds were good insulators with a resistance greater than 10^{12} ohms: after coating, the resistance between opposite faces fell to 10^6 ohms or thereabouts.

(*Continued on p.* 1271)