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They emphasize that these rules apply to actual defect sizes, and suggest further that sizes indicated by ultrasonic indications be tripled for aluminum alloys to account for discrepancies between observed and actual defect sizes. These suggestions are admittedly on the conservative side, but they should be considered until ultrasonic techniques have been refined to the point where there is better correlation between indicated and actual defect sizes.

C.R.W.

Shot-Peening and Prestressing of Springs

Digest of "Special Techniques for Increasing Strength and Fatigue Life of Steel Stressed in Torsion", by N. E. Hendrickson, *ASTM Bulletin*, No. 224, September 1957, p. 40-42.

THIS PAPER discusses the benefits derived from shot-peening and prestressing torsion bar springs for track-type vehicles. Prestressing is defined by the author as "the application of a controlled overload to produce permanent set in members in which the strains vary across the section". It is considered to be especially valuable where the loads are of considerable magnitude and in only one direction.

The torsion bar springs under discussion are about 59 in. long and 1 11/16 in. in body diameter with the ends being appropriately upset and splined for anchorage. They are made of Magnaflux-quality A 8660 Cr-Ni-Mo steel and are hardened in an electric resistance heater, with high-frequency booster coils at the upset ends. After heating to a temperature of 1550 to 1650° F., the red-hot bar is transferred to a special quenching machine that spins the bar between rollers as it cools in quenching oil at 125° F. After 2 to 3 min. in the spin quench, the bar is ejected and manually transferred to an oil tank at 250° F. Here the transformation to martensite is completed. Subsequent tempering is at 800° F. in a circulating hot-air furnace, giving a tempered martensitic structure of Rockwell C-48 throughout the section.

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Springs . . .

Following hardening and straightening, the body of the bar is shot-peened and then preset. The presetting operation is performed in a special hydraulic-powered twisting machine. The specification for the bar under study calls for a 75° twisting angle, which is about 50% beyond the elastic limit. Repeated twisting to 75° and unloading is employed. The set after the first twisting ranges between 15 and 20°; the second twisting usually gives another 2° set, while the next twist may give only ½° further set. This twisting or presetting is repeated until no further set occurs, which usually takes from three to six twisting cycles.

In the manufacturing program, any finished torsion bar may be picked at random for a fatigue test up to 50,000 cycles from 5° initial to 49° final twist. The 49° twist is the torsional elastic limit of the steel before presetting. During the fatigue test, the test bar is removed after 500, 1000, 5000, 10,000, 25,000 and 50,000 cycles and the permanent set recorded in each case. During the past four years, the author's company has run fatigue tests on 46 bars as routine checks on production from 27 heats of steel. Of these bars, 38 met the ordnance requirement of 5° maximum set after 50,000 cycles. The remaining eight bars were rejected because of insufficient hardenability.

To demonstrate that shot-peening and presetting are responsible for the extraordinary fatigue life of these torsion bars, fatigue tests were also run on bars in which these special operations had been partially or wholly omitted. Tests were run through the usual range of 5° initial to 49° final twist, and in each case the machine was adjusted after appreciable set had occurred to restore the full 44° maximum travel. In each case, the fatigue life was considerably inferior when the operations of shot-peening followed by presetting were not performed. In fact, it was estimated that shot-peening and presetting make it possible for 40 lb. of steel in these torsion bar springs to do a job that would otherwise require almost twice as much material.

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