A well-known American professor, R. F. Mehl, gave a lecture on thermomechanical treatment of steel at the Moscow Institute of Steels and Alloys, June 5, 1962. Professor Mehl indicated that up to the beginning of 1962 the work on thermomechanical treatment in the United States was being done essentially by two companies: United States Steel Corporation and Ford. High-temperature thermomechanical treatment has been investigated primarily at United Steel by Grange and his co-workers, while work on low-temperature thermomechanical treatment has been done essentially at Ford by Zeckley.

The first work on low-temperature thermomechanical treatment was published by Zeckley in 1958. He worked with various steels of the compositions given in Table 1. The composition of the steel was chosen so that the austenite was highly stable in the intermediate region. The alloys were rolled at 316–538°C, quenched in oil, and tempered for 1 h at different temperatures. The mechanical properties of these steels are shown in Figs. 1 and 2.

The ductility and strength increase after low-temperature thermomechanical treatment and quenching. Swaging of 25% increases the strength considerably.

Later, the following steels were subjected to low-temperature thermomechanical treatment: Vasco MA high-speed tool steel (0.55% C and 12% alloyed elements), N-11 steel (5% Cr, 1.3% Mo, 0.5% V, and 0.4% C), and 300M steel (4340 type) with a high concentration of silicon. Figure 3 shows that Vasco MA has optimal properties when it is swaged 90%. After tempering at 538°C and rolling at 593°C the characteristics are as follows: \( \sigma_s = 298 \) kg/mm\(^2\), \( \sigma_b = 323 \) kg/mm\(^2\), \( \delta = 8\% \), \( \psi = 35\% \). In this case only swaging of 50% or more produced a significant improvement in the mechanical properties.

N-11 steel, used for hot stamping, is also used as a structural steel, and although it contains a relatively small amount of carbon, the ultimate strength after low-temperature thermomechanical treatment reaches 263–280 kg/mm\(^2\), the ductility being either equal to or higher than after ordinary treatment (Fig. 4). The effect of the deformation temperature on the ductility was investigated at different degrees of swaging (Fig. 5). The deformation temperature must be determined for each particular steel to obtain the optimum combination of strength and ductility for a given degree of deformation.

Fatigue tests were run on N-11 steel after ordinary treatment and after low-temperature thermomechanical treatment. Large numbers of samples were tested on the standard R. R. Moore machine (10,000 cycles/min). The statistically treated results are given in Fig. 6.
Low-temperature thermomechanical treatment increases the fatigue resistance of N-11 steel 20-30% as compared to ordinary treatment and tempering.

The fatigue limit of this steel – 117.4 kg/mm² – is the highest ever recorded in the scientific literature.

The impact strength of 5M21 steel (13% Mo, 3% Ni, 0.2% C) after low-temperature and high-temperature thermomechanical treatments was determined with Charpy samples at the Ford laboratories. However, Professor Mehl has doubts about the very high values obtained in these tests.

The Ford laboratories and Manufacturing Engineering and Development have studied low-temperature thermomechanical treatment by extrusion. In this case all the stresses during deformation are compression stresses, and