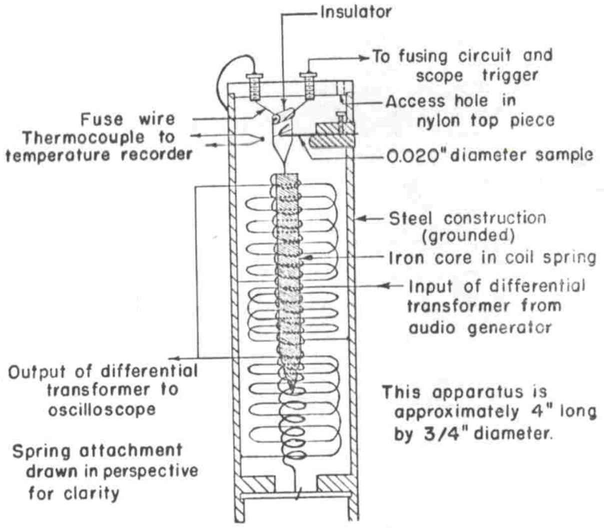

FIG. 1. Schematic of the stressing apparatus.

The temperature was controlled by immersing the pressure vessel in a water bath. The temperatures inside the pressure vessel were measured by a chromel–alumel thermocouple and Bristol Dynamaster Recorder, and compared with those of a thermocouple and a thermometer which were immersed in the temperature bath. The readings differed by less than 1/2°C.

The stressing apparatus (shown schematically in Fig. 1) fit inside of the pressure vessel. When the desired conditions of pressure and temperature were reached, the fuse wire was melted. The stretched spring then applied sufficient stress to the sample to cause failure and the spring (with iron core attached) moved down through the coils of a differential transformer.[10] The output of the transformer was fed into an oscilloscope which was triggered by the melting fuse wire. Thus, deflection was measured as a function of time by recording the scope sweep on film.

The samples were forced to bend around a mandrel of radius $R = 0.046$ in., and the maximum plastic strain was observed to be constant for all samples tested. The strain ϵ in the outer fiber of a cylindrical sample of radius $r = 0.01$ in. is thus $\epsilon = r/(r + R) \cong 18\%$.

At fracture, the electrical circuit through the sample, chassis, spring, and connecting parts was broken, and a voltage "kick" was observed in the output of the transformer.

The samples were cut into 3/4 in. lengths from 20 mil (99.95 + %) powder metallurgy molybdenum wire (purchased from the Fansteel Corporation). A sharp 1/16 in. bend was made at one end to serve as an attachment for the stressing spring. A 1-hr vacuum anneal at 1500°C resulted in an average recrystallized grain size of ~1/40 mm. The reported principal impurities (in per cent) were: C—0.005, O—0.004, N—0.001, W—0.008, Si—0.005, Ni—0.003, Cr—0.001, Ca—0.001, Cu—0.001, Ti—0.01, Sn—0.01, Mg—0.001.

The deflection rate was essentially independent of temperature and pressure (40 in./sec for the first 4 msec). After 4 to 5 msec, the deflection rate approached zero smoothly, after which the system remained essentially at rest. The maximum angle through which the ductile samples were observed to bend was ~60°.

The deflection of the sample due to contact with the mandrel would be expected to follow the geometrical relationship[10]

$$\frac{d\theta}{dt} = \frac{dx/dt}{[L - (R + r)\theta] \cos \theta}$$

where θ is the angle through which the rod is in contact with the mandrel, x is the deflection of the spring, and L is the original length of the lever arm (1/4 in.). From the above equation the "angular velocity" was calculated to increase from 160 rad/sec to 417 rad/sec in going from 0° to 60°. Assuming the strain rate is proportional to the angular velocity,[10] the strain rate increased by this same factor (2.6) during any given run. Although the exact value of the strain rate could not be determined exactly, it was assumed to be the same for all tests at the same sample deflection. The *maximum* strain rate was roughly estimated[10] to lie between 40 sec^{-1} and 40×10^3 sec^{-1}.

EXPERIMENTAL RESULTS

Deflection commenced immediately upon application of stress. The fracture usually occurred later by a time interval which depended upon both temperature and hydrostatic pressure (with a scatter of about 1–3 msec). At 25°C the average time to fracture increased from 2 msec at atmospheric pressure to 4 msec at 15,000 psi (~0.95 kbar). At 2°C the average time varied from 0.5 msec at atmospheric pressure to 4 msec at 27,500 psi (~1.9 kbar). At atmospheric pressure the average time varied from 0.5 msec at 2°C to 4 msec at 55°C. This might arise because the local strain rate increases with deformation in this geometry.

Considering the samples which hadn't broken after 4 msec to be ductile produces the transition region shown in Fig. 2. The black portion of the circles represented the fractions of six samples fractured according to this criterion. The 4 msec interval was