Stick-slip by hydrostatic extrusion is caused by the energy stored in the fluid at P_b being sufficient to overcome μ_s but much more than necessary for μ_k. Consequently extrusion occurs very rapidly and is accompanied by a sharp drop in pressure(1). The μ_s achieved at the P_r level apparently is not sufficiently greater than μ_k to cause stick-slip of the same magnitude to occur again.

Type D Curves. In these curves stick-slip is generally severe and continues throughout the stroke. Extrusion takes place at extremely rapid rates after each pressurizing stroke. The lower pressure level reached after each "slip" tends to occur at the same level during each cycle of stick-slip. Experimental results have indicated that this level represents fairly well the value of P_r if stick-slip had not occurred. For this reason, the level is designated as "P_r" to indicate that this is the apparent runout pressure. Often the amplitude of stick-slip ($P_b - P_r$) is about 30 percent greater than "P_r".

It is of interest to note that, because of the decreasing stick-slip in Curve D 2, a smooth runout might eventually be obtained if extrusion were continued further. In Curve D 3, a constant amplitude of stick-slip is superimposed on an increasing "P_r". As a contrast, however, the amplitude of stick-slip has also been observed to increase over an apparently constant "P_r" value as in Curve D 4.

V

ASSESSMENT OF FLUID HEATING EFFECTS DURING COMPRESSION

A study was made to determine the temperature change that occurs in the hydrostatic fluid during compression to various pressure levels at various stem speeds. Such information is of value in evaluation of lubrication systems and in precision calibration of the manganin gage used in measuring fluid pressure.

The faster the stem speed, the greater the amount of adiabatic heating of the fluid due to compression. If the fluid temperature reached just prior to extrusion is too high, the lubrication system may break down. Thus, it may be necessary to alter the lubrication system to suit the stem speed as well as the pressure level for optimum operation.

It was also considered important to determine the extent to which fluid temperature might influence the calibration of fluid-pressure readings as measured by the manganin gage. If the active manganin coil in the fluid is at a temperature much different than that of the compensating coil exposed to ambient temperature and pressure, an error may be introduced in the fluid-pressure measurements. The size of the error depends on the temperature difference. For example, if the active coil were at 120 F, calculations indicate that the pressure readings would be about 3000 psi low. The significance of this error, of course, depends on the pressure level during extrusion. (The error would be 3 per cent at 100,000 psi, 1.5 per cent at 200,000 psi, etc. The higher the pressure level, the less significant the error becomes.)

Of course, the temperature that the active coil attained during compression of the fluid would depend on the heat-transfer time available. Since the coil used in the program was encapsulated in a fluid-filled metal bellows, the heat transfer time would be appreciable. Furthermore, although faster stem speeds mean higher fluid temperatures, they simultaneously reduce the time available for heat transfer prior to and during extrusion. In reality, then, fluid-pressure measurements made at relatively fast stem speeds may not be very much in error. However, this was still conjecture, and it remained to determine for certain what, in fact, the quantitative effects of stem speed and pressure level are on fluid-temperature and -pressure measurements. Thus, it was considered worthwhile to undertake such a study.

Measurements of fluid-temperature fluctuations during compression were made with a Chromel-Alumel thermocouple sealed in a plug. The plug was made the same size and shape as a standard billet (1-3/4 inches in diameter x 6 inches long x 45-degree tapered nose) to simulate the heat sink provided by the billet prior to extrusion. The plug was inserted in a standard hydrostatic extrusion die to seal off the fluid. To prevent unintentional extrusion, the plug was hardened to R_C 60.

Temperature fluctuations in castor oil were measured during compression to pressures (nominal) of 100,000 psi, 200,000 psi, and 250,000 psi. Stem speeds were to be evaluated at each pressure level. The experimental data for a stem speed of 1 ipm are given below.