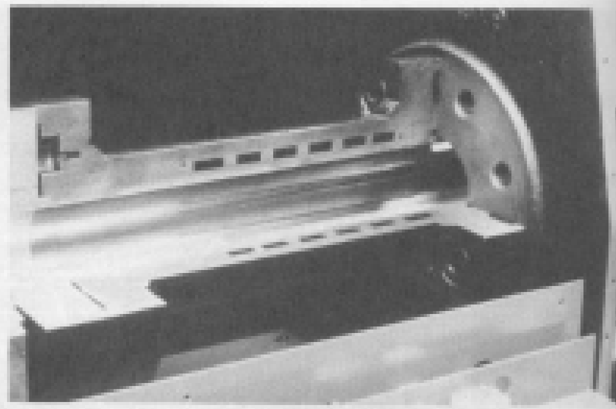
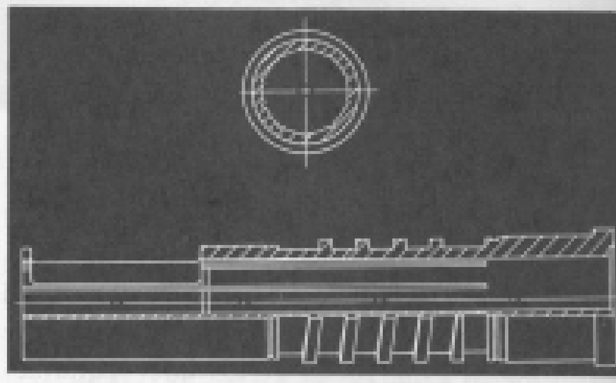
These materials include any highly lubricated formulations, members of the polypropylene family, and some of the high molecular weight high-density polyethylenes (HMW-HDPE). These low solids-conveying efficiencies usually lead to reduced output rates from the extruder, poor melting performance, and sometimes poor output consistency (output stability). The polypropylenes have enough conveying impetus to deliver moderate output levels and reasonable output stability as compared to easy-feeding materials such as most polyethylenes. When a material feeds very poorly, i.e., as screw speed is increased, the output increases very slightly or not at all, the extrusion process usually is unacceptable, and some feeding assistance is required.

Feed Section Design; Smooth Feed vs. Grooved. Typical commercially available polymers exhibit fair-to-excellent solids conveying; so the smooth bore of the feed section and barrel yield enough conveying force for stable extrusion at acceptable output rates. In these cases, melting and pumping performance can be maximized through screw design because no feeding inadequacies exist. When materials are encountered that do not have adequate solids conveying to allow the screw's melting or pumping functions to be reasonably maximized, feed assistance devices such as grooved feed sections are considered. (See Figs. 4-2 and 4-3.) These special feed sections contain grooves that start near the rear of the extruder's feed opening and continue past the feed opening area and usually beyond it by a distance of approximately three times the barrel inner diameter. The grooves usually are evenly spaced around the feed area's inner diameter and typically are deeper at their starting point at the rear of the feed section (gear case side). The grooves' depths then run out to the barrel inner diameter at their end. Typically, the grooves are cut axially along the feed section's bore; they also can be made in a helical configuration, which is believed to be more effective for the feeding of some materials but is more difficult to machine. Selection of the grooved feed section usually is justifiable only when there is a definite feeding problem. When the





Figs. 4-2 and 4-3. Grooved feed section. (*Courtesy Davis-Standard*)

material feeds moderately effectively, as most polypropylenes do, the use of a grooved feed section is debatable. When the use of a slightly larger extruder with a smooth bore feed section can match the performance of a grooved feed section extruder, the smooth bore usually is favored. Whenever additional extrusion features can be avoided in favor of operational simplicity with no sacrifice of performance, that is the favored choice.

The grooved feed section will increase output under most conditions with all materials, but if the screw is already pumping at or near the melting limits with a smooth bore feed section, any added output will not be useful. Grooved feed sections require intensive cooling to avoid melting in the grooved area, which defeats the conveying efficiency. Smooth bore feed sections are cooled typically, but only modest cooling levels are desired and required to avoid material softening and "bridging" in the feed area of the screw or in the feed throat.

The strong positive conveying efficiency of the grooved feed sections, when efficiently designed, causes high pressure levels at the end of the groove section, up to 10,000 to 20,000