

CNC Swiss-type lathes have enjoyed increased popularity in recent years. As companies fight to remain competitive, many find the best opportunities lie in complex turned components with small to medium lot sizes. Computerized numerical control has added capabilities to Swiss automatics that yesterday's cam machine designers could only dream of.

Swiss type turning first originated in Europe for the purpose of producing fine watch and clock components. The unique arrangement of the sliding headstock design gives this equipment the needed advantage to produce miniature and micro machined turned parts. The original cam operated Swiss type screw machines are used today for various high volume production projects. Today's computerized numerical controls (CNC) with its multi-axes ability are being used in a broader range of applications to produce several complex parts in one single operation. Most CNC Swiss screw machines are made in Japan by Star, Citizen, and Tsugami.

The Swiss cutting principle is based on the turning tool always cutting the material close to a support (the guide bushing). The bar is chucked in a collet and fed through a guide bushing and into the cutting tool by headstock that slides in the Z-axis direction.

The CNC Swiss machine not only permits complex parts to be completely machined in one setup, but it also permits many operations to be performed simultaneously instead of sequentially, substantially reducing the total time required to machine the part. For example, while the OD of the bar in the main spindle is being turned by one or more tools on the gang tool post, the four-spindle attachment described above can be drilling and tapping the front of the part. Or while the cross-drilling unit is drilling and tapping the (stopped) bar in the main spindle, the four-spindle attachment can be drilling and tapping the back end of the part in the subspindle. Synchronous control of the main and subspindle rotation and longitudinal movement permits the bar to be supported "between centers," for machining, which, among other things, eliminates cut off burrs.

### **Swiss Basics**

Here is what makes a Swiss-type lathe different: Z-axis motion comes from the workpiece feeding, not the tool. The tool moves in X—the radial direction—but not in Z, the direction parallel to the workpiece axis. In this direction, the workpiece is forced past the tool by a sliding headstock mechanism.

Contrast this approach with that of a conventional lathe having a fixed headstock. For example, turn a part chucked at one end and free at the other, and the tool engaging the workpiece in different places will see different degrees of support. As the tool moves away from the chuck toward the free end, workpiece deflection increases, potentially reducing tool life, accuracy, and surface quality.

The Swiss-type mechanism lets an OD tool always engage the part just a fraction of an inch from the guide bushing's support. This is true of an OD turning tool or a live tool. The stability that results lets the Swiss-type machine long parts—those with length-to-diameter ratios of 4:1 or greater—far more aggressively than other comparable lathes, without any loss to tool or tolerance.

There are some limitations. One is that the Swiss-type design makes it all but impossible to take multiple turning passes over the same area. Once the workpiece has been fed out, there is little freedom to retract it again. As a result, there is generally no sequence of rough, semi-finish, and finish in Swiss-type turning. Instead, these cuts must be made to finish depth.

Another limitation is that a Swiss-type machine must be sized to the job. A conventional lathe can machine workpieces in as wide a range of sizes as its chuck will permit. But on any given Swiss-

type machine, the range is more narrow. The work- piece must be fed through a guide bushing, and this guide bushing is only so big. A Swiss-type machine designed to run 0.75-inch bar stock can run smaller stock than this, but nothing larger.

Typically a "done-in-one" machine, a CNC Swiss-type, generally offers live tools, a subspindle, and a tool turret for back-face operations. Some conventional CNC lathes also offer all of these features. However, the CNC Swiss-type doesn't compete with these conventional lathes for single-setup work. The two machine types excel at different classes of parts. Instead, the CNC Swiss-type competes with multiple-setup processes, where turned blanks for complex parts may be machined on a simple CNC lathe or a multispindle automatic, then sent to a machining center, drilling machine, or some other subsequent station for critical follow-up operations.

A major difference is the need to take turning cuts at full depth instead of making multiple passes. This demand of a Swiss-type machine changes the way the programmer thinks about a process that isn't holding tolerance. On a conventional lathe, one way to achieve a more accurate process might be to take a deeper semi-finish pass in exchange for a lighter finishing cut. On a Swiss-type, an approach like this generally is not an option. However, an alternative may come from the subspindle, which on a Swiss-type is as much of a support device as it is a mechanism for back-face operations. For long work demanding more rigid holding, the subspindle can be programmed to "swallow" the part to a greater depth, and continue swallowing the part at ever deeper increments as the bar feeds out.