



COLD FORMING FOR HOT RESULTS

By Andrew Budai

A close-up photograph of a metal spline shaft being processed by a thread rolling machine. The shaft is positioned diagonally, and the machine's rollers are visible, creating a fine, uniform thread on the shaft's surface. The background is a solid teal color.

Roto-Flo's new CNC spline
and thread rolling machine
offers unique advantages
over hydraulic units.
Read on to learn
more about
how this is
achieved.

Cold forming involute splines, serrations, oil grooves, snap-ring grooves, threads, and various other features using spline rolling machinery provides many advantages and benefits over conventional methods such as hobbing. This process has typically been done by hydraulically actuated spline and thread rolling machines that use flat tooling blocks mounted parallel and over each other to cold roll features on shafts that are placed within and perpendicular to the tools. A cold rolling machine has four axes. Two axes represent the two tool slides that are the primary work slides and roll the feature. The other two axes are the head and tailstock that support the part, allow it to rotate, and move it in and out of the tool area. The headstock is on the inside of the machine, and the tailstock is the outboard support.

This method offers many benefits. One is a better part, because the process actually improves grain density and structure while minimizing stress concentrations that can lead to part failure through fatigue. Cold formed teeth and splines have 15-30 percent greater load capacity than cut teeth and splines. Surface finishes are much better, too—typically three to five microinches. So gears wear less and have reduced backlash. This cold forming process can also combine tapered, straight, and helical splines, worms, grooves, threads, and other features, plus a variety of different diameters on one part with one tool pass, which saves operator involvement (no moving parts in and out of hobs) and overall production cycle time.

Because parts are cold rolled rather than cut, there are no chips, and part material can be reduced, helping to reduce ever-increasing steel costs. In addition, cold forming tools are exceptionally durable, yielding much lower cost per part than cutting processes.

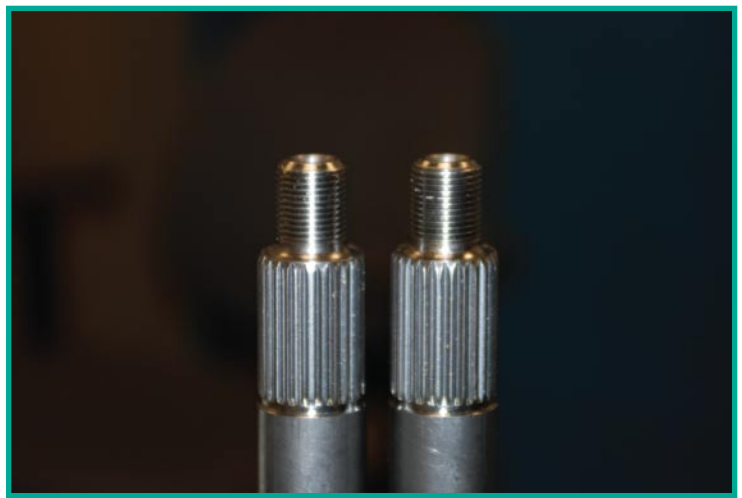


Figure 1: Output shaft with rolled thread and spline.

CNC Equipment Changes

For the past 60 years spline and thread cold rolling machines have used hydraulics to power the tooling slides along with the head and tailstock. But today there is another option: A/C servo actuated CNC equipment that gives added benefits over hydraulic equipment.

Roto-Flo has developed a new Model 3251 CNC machine to eliminate the problems of hydraulically actuated machinery. Although the company offers both types of equipment, new servo controlled machines can increase part throughput, dramatically shrink energy

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Model 3251 CNC Spline & Thread Rolling Machine

Roto-Flo's latest development is the Model 3251 CNC spline and thread rolling machine, which provides the following advantages over the company's conventional hydraulic machine:

- Significant energy reduction
- Increased process flexibility with variable ramping speeds and re-rolling capability
- Dimensional and spacing error correction via the control system
- Simplification of tool setting and part change over
- Reduced floor space
- Reduced noise levels

Specifications/ dimensions:

Maximum stroke: 54" (1372 mm)
 Maximum length of racks: 48" (1219 mm)
 Maximum outside diameter of part: 2" (50.8 mm)
 Range of diametral pitches: 16/32
 Length: 135" (3429 mm)
 Depth (including underarm): 132" (3352 mm)
 Height (including electrical panel): 74" (1879 mm)
 Approximate net weight: 31,500 lbs (14,500 kg.)
 Control system: Fanuc
 Servo motors: Fanuc
 Rack length: 48" (1220 mm) or less
 Part OD (approx.) 3-5/8" or less
 Rackbox Width: 6"
 Daylight opening: 8"
 Standard diametric pitch range: 16/32"

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Figure 2: Blank and finished output shaft with two rolled splines.

costs, and reduce plant floor space while increasing part accuracy for overall better quality. These systems are fully integrated, using the latest CNC controllers and AC servo motors from GE Fanuc to produce cold formed part features with high precision.

“Part throughput can increase by as much as 20 percent because of rapid traverse rates of over 1400 IPM offered by this new equipment,” according to Paul Simon, CEO. “By using servo motor technology with ballscrews to provide the variable and adjustable tool rack motion rather than fixed hydraulic systems, the tooling can rapid traverse to the part and then slow

down to entry feed rates for precise rolling. Tool life and part quality can also be increased, because the servo drives allow the forming process to be fine tuned.”

With hydraulic spline and thread rolling equipment a part is placed between the head and tailstock and a hydraulic system moves the part into the rolling area. Once rolled the tailstock must fully retract before the slides return to the home position. With a servo-controlled head and tailstock, however, the slides can return to the home position as soon as the part clears the tool area saving overall cycle time.

Hydraulically actuated rolling machines don’t have the ability to sense whether

the tooling is properly rolling the part. An oversized part creates the condition for a machine crash with the part jammed between the racks, and catastrophic damage can occur. But with a CNC controller running the ballscrew-driven tool slides, automatic load sensing can be programmed into the controller to detect any unusual force experienced during the rolling. Once detected the machine will stop and an automatic rack return will protect the machine from jamming, eliminating machine and tool damage.

Hydraulically actuated equipment is also expensive to run, Simon notes. And with energy costs continuously on the rise, these expenditures are increasing. However, he remarks, “With servo-controlled motors on the CNC equipment operating only when needed—unlike hydraulic systems that continuously run—energy costs will be dramatically reduced.”

Without a hydraulic system, floor space is also diminished. By removing everything that’s connected with the hydraulic system, maintenance is simplified because fluid, filters, cylinders, and other extraneous hydraulic components are no longer needed. Ancillary environmental expenses are also eliminated, such as hydraulic fluid recycling and oil cleanup, which helps keep a facility clean and free from oil that could cause slippery floors and polluted air.

AC-servo motors reduce noise levels by 50 percent. What’s more, without a large hydraulic motor running continuously waste motor heat is significantly decreased, saving on air conditioning and electric costs.

Simon says that when rolling threads or splines, sometimes an index error occurs, and a heal block for the tooling must be precision ground to correct it. Because a CNC servo-controlled system can be precisely controlled through software using programmed offsets, it eliminates any need for heal block grinding, tooling shims, or offset blocks for multiple rack designs. Overall equipment setup is faster, and instead of the operator making adjustments to stops and switches, he can simply input an offset in the CNC control to position the racks.

Another benefit is better part accuracy and precision. “Hydraulic systems only allow a part to be rolled once unless the machine is modified,” Simon says, “and even then it’s a cumbersome process.” Some part features might require re-rolling. With the CNC equipment that accurately

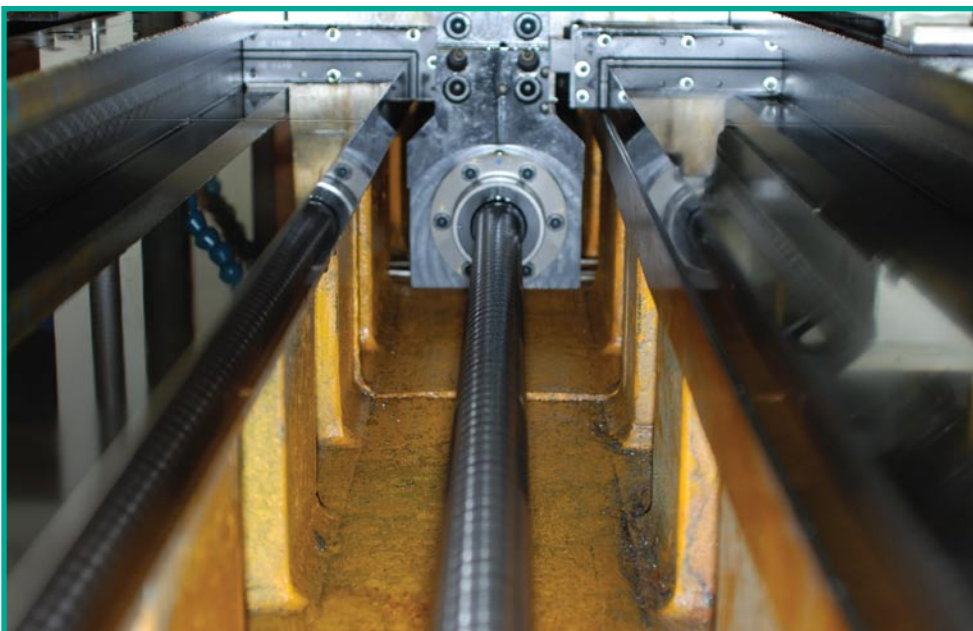


Figure 3: Roller screw drive for servo slide system

synchronizes the tool racks, parts can be re-rolled as needed to enhance a specific feature and give overall better precision and quality.

Because the controller can infinitely change the ballscrew speed, tooling feed rates are variable. An engineer can easily program the control for slow entry feed rates and fast retraction, which allows optimal feed rates to be dialed-in to improve part quality or tool life.

Servo-controlled head and tail stocks allow faster and easier part set up, too. The operator just inputs the proper information in the control to automatically move the head and tail stocks to their proper positions; no stops or screws need manual adjusting. Part changeovers are quickly done because part programs are saved in the CNC control and called up for later use. And although the company can build a full CNC servo-controlled machine, a customer might not want the head and tailstock to be controlled this way. Roto-Flo can easily offer any combination of machine functions, from full CNC servo control to having hydraulically driven tool slides and a servo-driven system for the head and tailstock, working with a customer to design and build whatever will give them the greatest production and fit for their manufacturing system.


A Roto-Flo CNC machine is easily automated, according to George Simon, the company's president. "Robots, walking beam and overhead transfers, a wide variety of conveyors, and virtually any other form of automation is available for either a hydraulic or CNC rolling machine installation," he says.

Tailored Tooling

Tooling for spline and thread rolling machines is unusual, says Don Ritter, sales and marketing manager of Roto-Flo's sister company, U.S. Gear Tools, which provides tooling from design to production for this equipment. "When you look at a rolling rack, it actually has four surfaces," he says. "Lead in, which is tapered, then the main rolling area that does most of the metal displacement, and then a finishing and roll out area. With a CNC cold rolling machine, you can actually program these points and adjust feed rates so that it's very precise and controllable."

U.S. Gear Tools will work with the customer to provide the proper tool to produce the exact feature(s) needed. "If you bring us a shaft, and we're going to make that tool for you the first time, we'll run parts to make sure that the

first rack will produce the required part specifications," he says. "We'll produce the rack tools, run parts and send our customer the run charts with the tool rack. It's a full turnkey operation. If they want us to run prototype or production work, we're capable of doing that, too, since that's another service we offer."

With in-house machine design and build capabilities, tooling, and automation, Roto-Flo offers a complete solution to providing cold formed part features. 

ABOUT THE AUTHOR:

Andrew Budai is director of operations at Roto-Flo, a division of U.S. Equipment Company. To learn more call (313) 526-7865, send e-mail to info@roto-flo.com, or go online to [www.roto-flo.com]. Also visit IMTS booth # B-7511.

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