METALCUTTING CORPORATION

The Nuts & Bolts of Swiss Screw Machining

Everything you need to know about including Swiss lathe capability into your process plan

Like many OEMs you may be looking to improve part quality for a difficult geometry, reduce production time and cost, and decrease time to market. In your efforts to achieve these goals you'll likely have run across a Swiss screw machine at some point. But, have you thought about how including a contract partner with Swiss screw machining capability in your process plan could help you meet your goals? Do you know how it might benefit your bottom line? Or if it could consistently improve part quality? This white paper aims to offer an in-depth view of this diverse capability by exploring some of the most frequently asked questions, including:

- Why is it called "Swiss" and what does it have to do with Screws?
- What makes a Swiss screw machine unique?
- What are the advantages of using a Swiss screw machine?
- How does a Swiss screw machine deliver these advantages?
- Will I get quality and precision in the final product?
- How do I save time?
- How will I save money on component fabrication? and:
- What industries and applications benefit from parts fabricated by a Swiss screw machine?

Why is it called "Swiss" and what does it have to do with Screws?

The Swiss machine has its origins in the Swiss watch industry, where the need to turn long, thin, intricate parts (mostly watch screws) with relative speed and accuracy was invaluable to production. At the crest of the industrial revolution, a competitive watchmaker had to not only produce exceptional quality, but also large quantity. A measure of automation was the key to success. Though today's machines may have far surpassed the level of precision for which these watches were made famous, the very same technology that made them possible continues to be a vital part of the industrial landscape today.

What makes a Swiss screw machine unique?

In recent years, CNC Swiss Type Machines have quickly become the must have piece of value-added equipment for component manufacturers. Why? Because with an ever-increasing array of tooling capabilities, improvements in servo communication and speed, and the virtual elimination of secondary operations these machines (unlike older lathe machines) provide the mid-sized contract manufacturer an invaluable competitive edge.

Today, an automatic Swiss type lathe would be unrecognizable to those early nineteenth century watchmakers. Modern machines use a disc cam to rotate tooling to a workpiece, which is held in place by a collet and supported by a guide bushing. Disc cams move the tools in a radial motion while simultaneously altering the headstock position.

With the addition of Computer Numerical Controls (or CNC) in the 1970's, tooling areas began to include turrets and gang slides, as well as secondary spindles, which improved speed and accuracy. When parts are rotating at speeds upwards of 10,000 RPM and tolerances are anywhere between ±0.0002" and ±0.0005," machines can support high volume requirements with just a single operator. That translates to more parts in less time at a competitive price.

Since then, improvements in servomotors and controls, as well as high pressure coolants have made Swiss machines a permanent fixture across industries–in particular, the medical device and aerospace markets where exceptional tolerances, difficult geometries and exotic metals and alloys are common.

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What are the advantages of using a Swiss style lathe?

The Swiss machine was designed to improve repeatability and quality of production components by leveraging such attributes as a bar stock feeder, guide bushing, and second spindle. Generally, these advantages include:

1. Increased productivity, which translates to lower cost per piece and less time to fabricate.
2. Reduced set-up and tool change time shortens production times on repeat orders and decreases long term cost per part.
3. Improved uptime resulting from improvements in programming, and the bar feed system of the Swiss style lathe which allow a machine to run unattended on a lights-out schedule.

How does a Swiss screw machine deliver these advantages?

Bar stock is fed through a chucking collet, where the headstock clamps on to it. The bar is located by a guide bushing, and then emerges into the tool zone. Unlike a conventional lathe where the headstock remains stationary, the headstock of the Swiss style lathe moves along the Z-axis. The motion of the bar acts as the feed for material removal. Many of the advantages of Swiss screw machining are the result of a robust set of turning tools and the architecture of the machine. For example:

1. Because the Swiss screw machine fabricates parts by moving the material and tool simultaneously, up-time and tool wear rates are reduced.
2. Additionally some types of machines can accommodate 20 or more tools in the tool zone, many with live tooling. The vast array of tools combined with a sub spindle and back working stations, virtually eliminate the need for secondary operations, making the Swiss machine ideal for complex parts requiring several unique operations.
3. Often Swiss screw machines can produce finished, ready-to-ship pieces. The close geometry of the machine–which allows for the tool to work within millimeters of the work piece–reduces chip-to-chip time to a second or less.

Will I get quality and precision in the final product?

A work piece subjected to force will deflect; as such, most cutting methods (i.e., lathes) must make several slow passes to remove material. Conventional wisdom would suggest that the more passes, the greater the margin of error, particularly over long lengths (generally diameter ratios greater than 3:1). This would have been an especially big concern for those Swiss watchmakers, turning long thin parts. It isn't surprising then, that the chucking collet, which provides stability to the work piece, was patented in the 1870s.

The modern Swiss machine's secret to the efficiency and accuracy is all in the guide bushing, which provides rigidity to the material by supporting it close to the tool. This effectively reduces deflection to zero, which means the cutting tool can make one deep pass rather than several shallow ones, reducing tool wear rates and makes for more consistency and accuracy.

There are two types of guide bushing:
1. Rotary Guide Bushings rotate simultaneously with the work piece, and are best used when turning wider parts, with tolerances greater than ±0.0005."
2. Fixed Guide Bushing, which remain static while bar stock spins, are best if tighter tolerances are required.

Additionally, high precision guide bushings are available for difficult materials or tough tolerances. Coaxiality, which is a measure of concentricity of multiple diameters along a theoretical axis is used to indicate guide bushing accuracy. To be able to consistently hold micron tolerances over time, guide bushings should have a coaxiality of 0.0002".

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However, the guide bushing alone is not enough to ensure perfect parts. In fact, a worn bushing or the use of a guide bushing when not necessary can actually result in inaccuracies. That said, ensuring dimensional accuracy requires proper configuration, adjustment and monitoring.

Successfully machining exceptionally tight tolerance parts is often a considerable asset for many part makers in fields such as medical device or orthopedics. But micron tolerance specs can pose process challenges to repeatability. Segmentation, a tactic that leverages the full benefit of the guide bushing, fabricates one portion of the work piece at a time as it advances, can improve consistency.

How do I save time?

Reducing production time on a Swiss machine depends both on part size–particularly diameter–and volumes. Not all machines are suited for small runs or for complex jobs. In fact machines designed to handle larger part sizes may be ideal for small runs of complex parts, as gang slides and turrets can be outfitted with specific sets of tools to reduce set-up and retooling for running several different jobs in succession.

However, large production runs of simple, small-diameter turned parts are likely more appropriate for Swiss style machines designed to accommodate smaller diameter bar stock. Notably, less complex, more compact machines can sometimes outperform their more sophisticated rivals when producing certain geometries. In addition, smart tooling choices and macros enabled programming can also influence set-up-time and changeover speeds.

Another feature of the Swiss style machine which reduces up-time is the bar feed system. Generally, there are two types of material delivery systems, each engineered to support specific volume requirements and part complexities. They are:

1. Hydrostatic: The stock sits in a series of plastic channels, which close around it and hold it in place. Typically oil is then pumped into the closed guide channel to provide stability, while the independent, servomotor controlled feed mechanism advances the material during the turning operation. Hydrostatic bar feed systems generally have a 12' stock capacity, which is automatically reloaded in a magazine style system.

2. Hydrodynamic: The Hydrodynamic Bar Feed System holds the bar stock in a feed tube, which is then surrounded by pressurized flowing oil. The oil not only provides a hydrodynamic wedge, centering the bar stock in the tube, but it also acts as a noise dampener and the force on the piston that advances the stock. This bar feed system requires manual reloading of individual stock pieces.

When considering a contract partner with Swiss style turning capability, be mindful that the feed syste--in relationship to your volume requirements, part length and cycle time--could have a significant impact on your bottom line. A general guideline is for part runs in the thousands (i.e., high volume), less complex geometries or common materials a hydrostatic bar feed system is best. Smaller runs, R&D work, or difficult materials requiring longer cycle times are better suited to a hydrodynamic system, where an operator will either be in attendance and can manage manual reloading.

An additional advantage of a hydrodynamic bar feed system is increased bar stock stability resulting from the tight diameter of the feed tube. This added rigidity is especially beneficial because many single spindle machines run at higher than average rpm, allowing operators to maximize their machines' up-time.

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How will I save money on component fabrication?

The advent of the screw machine was driven by profitability. Today, it continues to provide innumerable benefits related to time-savings and labor reduction for the manufacturer, which ultimately translate to costs savings for the end user.

Use of Automation

Automation is an obvious cost savings, as it reduces set-up costs, machine up-time, and labor costs, and reduces production run time by combining operations into a single set-up, or leveraging gang slides and turrets to run several limited production parts consecutively.

Decrease in Labor Costs

A Swiss style lathe requires only one operator to run multiple machines, and can often run on an unattended, lights out schedule.

Elimination of Secondary Operations

Live tooling on sub spindles enables multiple machining operations on one machine, which reduces overall machining costs on complex parts. With the ability mill, drill, ream, saw, thread, polish and more, Swiss style machines complete and drop parts ready to ship.

Better Quality

Components which are reliably turned to spec reduce costs related to returned parts, such as shipment, restocking, as well as delayed lead time and re-tooling costs.

Reduction of Scrap

Though typically Swiss style machines leave a 6" to 12" remnant (which can be costly, especially if the material is a precious metal), smart manufacturers will find ways to either reuse the scrap, or will elect to weld an additional piece of inexpensive stock to the end of the high-value material rendering the entire length of the material useable. Additionally, knowledgeable programming exploits the range of the machines capabilities, and leverages its efficiency to reduce waste.

What industries and applications benefit from parts fabricated by a Swiss screw machine?

Accuracy, quick production times, and a reduction in variable costs have made Swiss style machining the process of choice for a variety of industries and their applications. Industries that require high precision metal machining include aerospace, defense, electronics, medical, and automotive. The following is an overview of these industries and relevant applications:

Aerospace

Precision machined components are critical for safe and secure operation of aerospace equipment and engines. As such Swiss screw machining is utilized in the fabrication of various mechanical parts for airplane and space craft motors, wings, and wheels as well as electrical components for cockpit controls. Swiss screw machining ensures the product meets the aerospace industry's rigorous demands, which include ultra-tight tolerances, and exceptional finishes. Common materials typically include titanium, aluminum, and stainless steel.

Defense

The exceptional accuracy of Swiss style machines make them well suited for the complex geometries required for parts used in defense helicopters, tanks, missiles, ships, and aircraft, where proper end-use functionality is a must. Materials commonly used in defense manufacturing including brass, copper, titanium, stainless steel and even some plastics are readily manufactured. Swiss machines easily take on the precision requirements of Mil-Spec parts for tanks, ships, missiles, and aircraft where there is no room for error.

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Electronics

In the electronics sector, precise machining is used to produce components such as fine threaded screws, connectors, solder cups, test probes, and Nano-tubes that go into various electronic panels, printed circuit boards, controls, and interfaces. As computers, phones, tablets, and other electronics become more compact and intricate, Swiss screw machining will continue to a pivotal part of meeting demands for tighter tolerances, exceptional quality, and smoother finishes.

Medical

In the medical sector, precision machining processes are well suited for medical implants, medical instruments, surgical tools, catheters, surgical needles, joint replacements, and components for respirators and ventilators. A growing demand for more precision, tighter tolerances and smaller components has made Swiss style turning a top of mind process for the medical sector.

Automotive

The automotive industry uses Swiss capability to produce bushings, carburetor components, shafts, housings, pins, suspension components, brake system components, and timing covers. The Swiss screw machine operation provides automotive OEMs with reliably accurate parts.

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Find Out More

Does Metal Cutting Corporation offer Swiss Screw Machining?

Metal Cutting Corporation's experience in precision metal fabrication dates back to 1967, providing customers burr-free, abrasive cut-off of metal parts that meet or exceed all tolerance requirements. The company manufactures precision metal parts for every market segment requiring tight tolerances.

The addition of the Citizen K16E Sliding Headstock Type Automatic CNC Lathe offers a new level of precision metal machining and represents the company's determination to provide customers with a solution for exceptionally accurate, specialized components.

General Processes

The Citizen K16E offers capabilities including boring, drilling, hexing, milling, polishing, slotting, and turning. Threading, including internal and external, premium and tapping are also available.

Equipment Capabilities

Metal Cutting's newly acquired 7-axis, automatic Swiss style lathe running DelCam Partsmaker software is pushing limits of already exceptional tolerances.

Materials

Metal Cutting, Corporation can process both customer supplied and internally sourced materials; we have an extensive network of sourcing partners that can provide the right materials.

Part Sizes and Lengths

Metal Cutting Corporation is able to produce part sizes from 0.625" down to .030" (min) and part lengths from 0.62" to 4" (longer parts require altering the machine), and regularly achieves up to a 16 Ra (and better) finish.

What should I do next?

Metal Cutting Corporation is committed to providing customers a vertically integrated solution for all their precision metal machining needs. Please contact a sales representative by calling 1-800-783-6382, direct general sales questions to sales@metalcutting.com or info@metalcutting.com to learn more about the company's Swiss style machining capabilities or to request a quote.

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