Mill Tool Holding Alternatives – Power Drawbars versus Quick Change

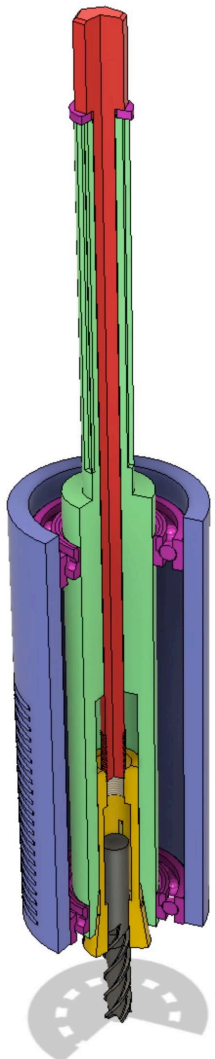
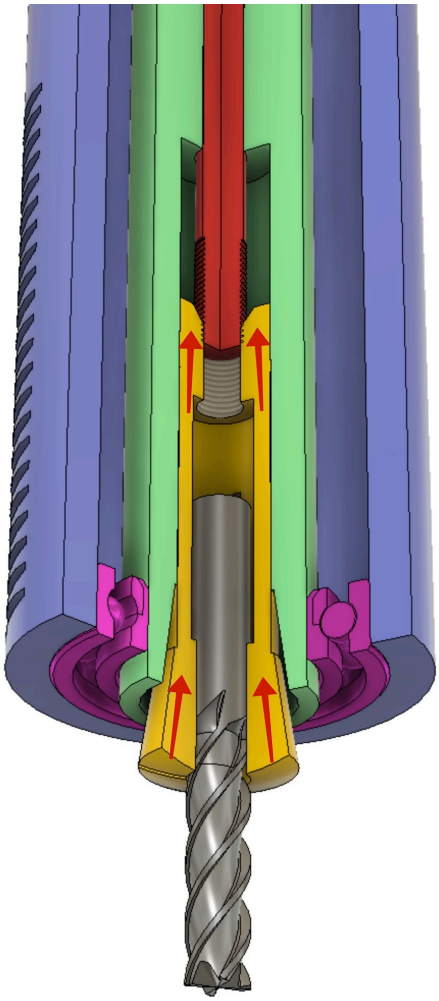
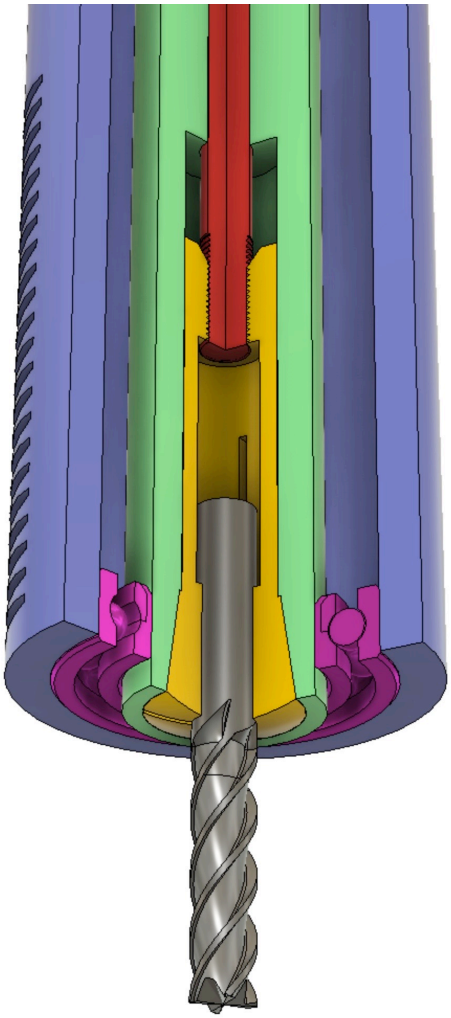
– one user's perspective: pros, cons, and trade-offs

Methods of securing tooling and tool holders to R8 mill spindles can take many forms. This document is an overview of several types and amplifies some of the tradeoffs between the various types.

Most mills with an R8 spindle taper have a "drawbar" which is nothing more than a hex-headed bolt with a very long shaft. This drawbar runs through a hole down the center of the mill spindle, with the head of the "bolt" at the top of the spindle, and at the other end of the shaft is a threaded section that screws into an R8-compatible tool holder such as a collet or drill chuck arbor.

A typical setup of this nature is illustrated below in a cut-away view of a typical mill spindle. As the drawbar (shown in red) is rotated clockwise, the threaded end of the drawbar engages with and pulls up on the toolholder (shown in yellow) as the drawbar is rotated clockwise (viewed from the top). In the process, the toolholder is forced into the spindle taper causing an R8 collet to compress and squeeze around the shank of the tool, securing and simultaneously aligning the tool to the center of the spindle axis of rotation. Other R8 tooling (such as a drill arbor or shell mill arbor) do not compress but the taper ensures the tool repeatably aligns to the spindle axis of rotation.

Color Codes: Blue=Quill; Purple=Spindle Bearings; Green=Spindle; Red=Drawbar, Yellow=R8 Tool

Cut-away View of a Typical R8 Spindle Assembly	**R8 Collet Being Retracted by the Drawbar**	**R8 Collet Fully Seated and End Mill Tool Secured by Clamping Action**
		

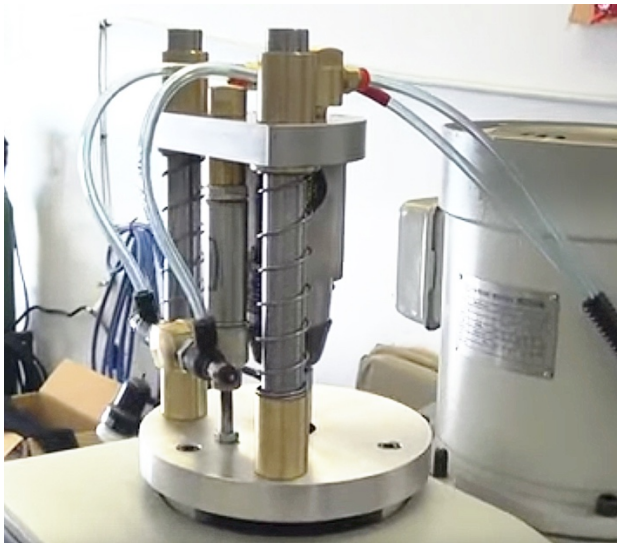
To make tool changes on an R8 spindle, the operator can manually screw and unscrew the drawbar in the spindle using a hex-wrench or drawbar hammer (a specialized tool having a hex socket on one side and a brass hammer head on the other). The operator must be able to reach the top of the spindle when it's fully retracted (some mills would require a ladder or step stool to reach the top of the drawbar). Additionally, some type of spindle locking mechanism or wrench must be employed while manually rotating the head of the drawbar. Changing tools in this manner can become tiresome very quickly. And with both hands involved in the process, it also requires special precautions to prevent the tool in the spindle from falling out and becoming damaged as it hits the machine table or vise. Frequently, simply unscrewing the drawbar does not cause a tight-fitting tool to drop free from the R8 spindle taper unless the top of the drawbar receives a downward blow by a hammer (hence the existence of the "drawbar hammer" tool mentioned above).

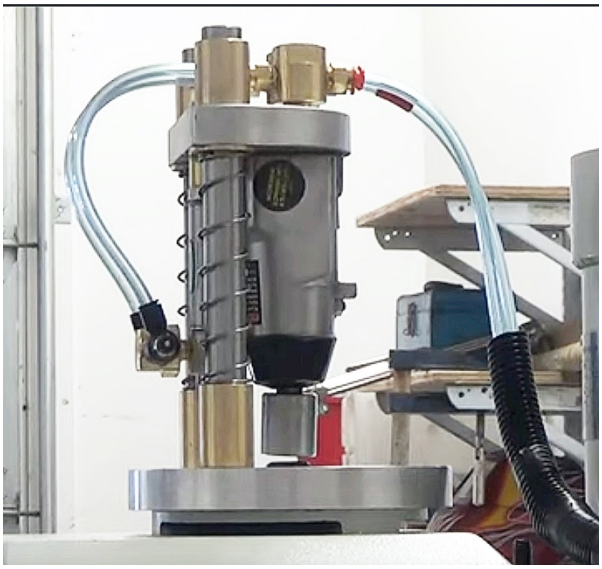
To make tool changing easier and quicker, many users will add a specialized device, typically driven by compressed air, to automate the process and make it as simple as pressing a button. These devices are often referred to as a "Power Drawbar" or "PDB". There are two common types of power drawbars.

The conventional types employ an impact driver, typically air driven, with a hex-socket that is lowered down onto the top of the drawbar, and the impact driver rotates the drawbar in one direction or the other to secure or release the R8 tool in the spindle. The hammering nature of the impact driver eliminates the need for a spindle locking mechanism, and also works to jar loose the tool that is wedged into the R8 taper.

There are commercial units available for Bridgeport type knee mills, and many DIY solutions are documented on YouTube employing a Harbor Freight (or similar) impact driver. The premium commercial brand in this category is Maxi Torque Rite - it's what I have on my PM-935 and comes with a custom drawbar specifically sized to the spindle length. The Maxi drawbar includes a hardened and splined top head for long term durability. Kurt is another brand that makes a similar power drawbar. Precision Matthews sells the Maxi Torque Right units that fit their knee mills.

The Maxi unit is sold through distributors, but I recommend working directly with the manufacturer to make sure the drawbar they provide is properly sized for your specific mill. The best and most compact design I've seen for a conventional DIY PDB looks like this when finished.





The build videos for the DIY version shown above are available at the following links - there are two videos in the series:

https://www.youtube.com/watch?v=qInoQyRNUxI

https://www.youtube.com/watch?v=CX4Ous-DOlQ

Since there are no commercially available PDB of this type for benchtop milling machines, many users are forced to either build their own PDB or adapt one of the commercially available units to their mill with a custom mounting platform that is shop-built.

The second common type of power drawbar system is the Tormach Tooling System. It was invented by Tormach and is commonly referred to as the TTS (Tormach Tooling System). Each tool must be fitted with a dedicated TTS toolholder, and the R8 spindle is fitted with a TTS-compatible collet chuck. Strictly speaking, the TTS isn't actually a PDB, but is an air-powered collet closure device. The TTS collet at the spindle nose is actuated by moving a conventional drawbar up and down, causing the collet to either close on the TTS toolholder, or spring open and release the toolholder. The following link provides an animation that covers the basic concept:

https://www.youtube.com/watch?v=Kt8ueNzUEBA

Below is a link to the TTS product lineup that illustrates the R8 collet and the various tool holder types available for the system:

https://tormach.com/tooling/tool-holding/mill-tool-holding/tts.html

With the TTS system, the mechanism that pulls up on the drawbar is nothing more than a stack of Belleview washers that act as a spring to keep the drawbar pulled upward. To release the collet, an air cylinder is actuated that pushes down on the drawbar, overcoming the upward tension of the Belleview washers – this, in turn, forces the drawbar downward, causing the collet chuck to spring open, releasing TTS collet holding the tool. The disadvantage with the TTS system is that its holding power is less than a conventionally tightened drawbar. For medium-duty work, the TTS can be a good choice. But some users complain about tool pull-out under loads - especially end milling or spiral drilling into hard materials like steel or stainless. One advantage of the TTS system is that your tool will register to the same stick-out distance each time it is loaded. For CNC conversions, the TTS system makes a lot of sense since the tool position is already known when the tool is loaded – making it ideal for an automatic tool changer setup.

Priest Tools manufacturers a TTS PDB setup that will fit the PM-833 and other small benchtop mills. A demonstration of it is in the following link: https://www.youtube.com/watch?v=Ccof3ac9_uc

Quick Change Systems

An alternative to the drawbar-type systems described above is a Quick Change toolholder system. There are three types of R8 quick change tool holding systems commercially available.

PDQ Marlin Manufacturing makes an R8 compatible Master Holder and a wide variety of tool holder types that mate with it. Since the PDQ system installs via the normal R8 drawbar, it is possible to conveniently move back and forth between PDQ and conventional R8 tooling. I have personal experience with these tools, and found them to be very well made, but not sufficiently accurate from a repeatable tolerance perspective. I ended up selling my PDQ QC tool holding components and changing over to the more accurate system by Royal.

Mach-1 offers a quick-change system based on a replacement drawbar that is mechanically actuated via the quill and opens a proprietary tool collet at the nose-end of the spindle. Each tool must be mounted in a proprietary toolholder provided by Mach-1. The principal drawback to the Mach-1 system is that all tools must be mounted in proprietary toolholders, and once the system is installed,

reverting to a conventional R8 drawbar setup requires complete removal of the Mach-1 system. This makes it unrealistic to swap back and forth between traditional R8 drawbar setup and the Mach-1.

The Royal Quick-Change R8 tooling system is often branded "EasyChange". It consists of a master holder that mounts in the R8 spindle using the normal drawbar to secure it in position. Each tool used with the system will require a dedicated toolholder specifically designed to mate with the master holder. In my experience, this system can be an excellent alternative to a power drawbar setup and offers decent TIR repeatability (alignment of the tool to the spindle axis). But it does have some limitations. In general, the Royal PDQ setup is not well suited for excessively heavy machining with face mills or the pounding action of a fly cutter making interrupted cuts. But for drilling, tapping, and end mill use up to about 3/4" diameter, the system is very convenient. Mr. Pete (aka Tubalcain) has a nice overview of the system at the following link: https://youtu.be/CywoSKpwua8

Shown below is my tooling setup with the Royal EasyChange system.

I find this Royal EasyChange setup very useful and preferable to my Maxi power drawbar for quick tool change sequences such as spot drill, drill, chamfer, and tapping in sequence as illustrated here. I do swap back and forth between the EasyChange system and using a conventional drawbar for more aggressive tooling such as indexable end mills, face mills, and heavy boring head operations.

If you are interested in acquiring and using the Royal EasyChange system, the following pages include my specific recommendations on what to buy to get started.

Most of the components that make up the system can be acquired from the United Kingdom at substantial discounts to what you would pay in the USA. Rotagrip in the UK is one such distributor I purchase from frequently. Their listed prices include VAT tax which will be subtracted from the price when the product is sold and shipped to the USA. In general, I have found the shipping charges to be roughly equivalent to the VAT tax but can vary considerably depending on weight.

When deciding to invest in the Royal EasyChange system, your first decision should concern the drill chucks you intend to use - that will determine the Jacobs taper required for the EasyChange drill chuck adapters. Settle that question first keeping in mind the Jacobs taper choices offered by the Royal system. Ideally, the setup would include one keyless chuck and one keyed chuck with each chuck on separate EasyChange adapters. Going a bit further, I can recommend an Albrecht Keyless, and a Vertex

Keyed chuck specifically. If you don't want to spend the money on an Albrecht, then a Rohm Keyless is an excellent alternative. The chuck versions I have are all 5/8" max capacity (3-16mm) and can be found on the "Get Started" list that follows. A keyed chuck is an important addition if you intend to perform power tapping operations in harder metals.

Next, consider your end mill needs. I have end mill holders up to and including 3/4", but I would recommend sticking with 1/4, 3/8, and 1/2" end mill holders with the EasyChange system. In my case, and strictly for convenience, I have duplicates of each end mill holder size – one for aluminum tooling, the other for steel tooling. The system is not really well suited for 3/4" end mills performing slotting or aggressive hogging operations, although I have that size holder and use it for finishing cuts with an end mill, or for a boring head setup. The number and specific sizes of end mill holders will vary depending on your needs. What I have listed below is what I would consider a reasonable "Get Started" set.

For end mills under 1/4" in diameter, it's preferable to mount them in an ER32 collet. This is so the end mill shank can be tap it into "close to zero" TIR. Runout on an end mill becomes increasingly important as the diameter decreases – a 1/8" carbide end mill with a 0.005" TIR will likely fracture under load. With an ER32 collet setup, you can slightly shift the end mill position in the ER collet to get the TIR to zero. I refer you to this video. Also, an ER32 collet is an excellent way to hold and odd-sized tool shank such as metric tooling.

You will want some type of edge finder and a dedicated EasyChange end mill holder for it. If you use a conventional mechanical edge finder like a Starrett 827A, then you'll want a 3/8" end mill holder dedicated specifically to that. If you have a 3D edge finder like the Haimer or Tschorn, then you'll want an end mill holder that matches the shank of that instrument. I have a Haimer edge finder that has a 12mm shank, and I hold that in a 12mm EasyChange end mill holder. I also have the Tschorn 3D Tester SLIMplus v2 which I have in an EasyChange 1/2" end mill holder.

Royal EasyChange Suggestions - Get Started List

Category	Recommended Option with Hyperlink
R8 Master Holder	Royal EasyChange Master Holder R8
Drill Chuck Related	Albrecht Keyless Drill Chuck J6 Taper 3-16mm
	Alternative: Vertex Precision Keyless Drill Chuck J6 3-16mm
	Royal Easychange Drill Chuck Adapter J6 for Above
	Vertex Ball Bearing Keyed Drill Chuck J3 3-16mm
	Royal Easychange Drill Chuck Adapter J3 for Above
ER32 Collet Chuck	Royal EasyChange ER32 Collet Chuck
	My preference on ER32 collets is Vertex or TMX brand
End Mill Holders	Royal EasyChange 1/2" End Mill Holder
	Royal EasyChange 3/8" End Mill Holder
	Royal EasyChange 1/4" End Mill Holder
3/8" Edge Finder Holder	Royal EasyChange 3/8" End Mill Holder
12mm Haimer Edge Finder Holder	Royal EasyChange 12mm End Mill Holder
Tschorn Edge Finder Holder	Royal EasyChange 1/2" End Mill Holder