About R8, ER, and 5C collets and their use

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R8, ER, and 5C collets all work by pulling or pushing the collet into a tapered hole, which in turn causes the collet to contract and secure the workpiece or tool being held by the collet. Collets are essentially tapered cylinders with a hole for the part or tool to be clamped. The collet is split in a few locations around its perimeter such that it compresses or tightens against whatever is being held in the collet when the collet is forced into a tapered hole that precisely fits the taper of the collet.

R8 Collets

An R8 collet has three splits 120° apart around the side and is used almost exclusively for securing tooling into a mill spindle. A drawbar is used to pull the collet into the spindle taper, and this causes the collet to contract around the tool or material in the collet. R8 collets are available in sets of common imperial and metric sizes. Practically, speaking, since R8 collets are used almost exclusively to hold tools such as end mills, so you don't need the full 25 piece imperial set if you are using imperial tools since they come in shank sizes that are multiples of 1/16" diameter. The 1/32" collets that fall in between the major 1/16" divisions would be used very infrequently. An R8 collet has a very narrow range of compression – typically limited to 0.005-0007". If you plan to hold metric tooling in an R8 collet, you will need metric collets that correspond to the diameter of the tool. Given the narrow range of clamping, odd-sized tooling (e.g., 8.5mm) should be held in an ER collet rather than R8.

Shown below is are typical R8 collets – note the three splits around the perimeter of the collet and the tapered nose. In use, a drawbar is tightened into the small end of the R8 collet (nominally threaded 7/16 x 20), causing the collet to be pulled up and into the spindle taper, which in turn causes the nose section of the collet to compress around the tool.

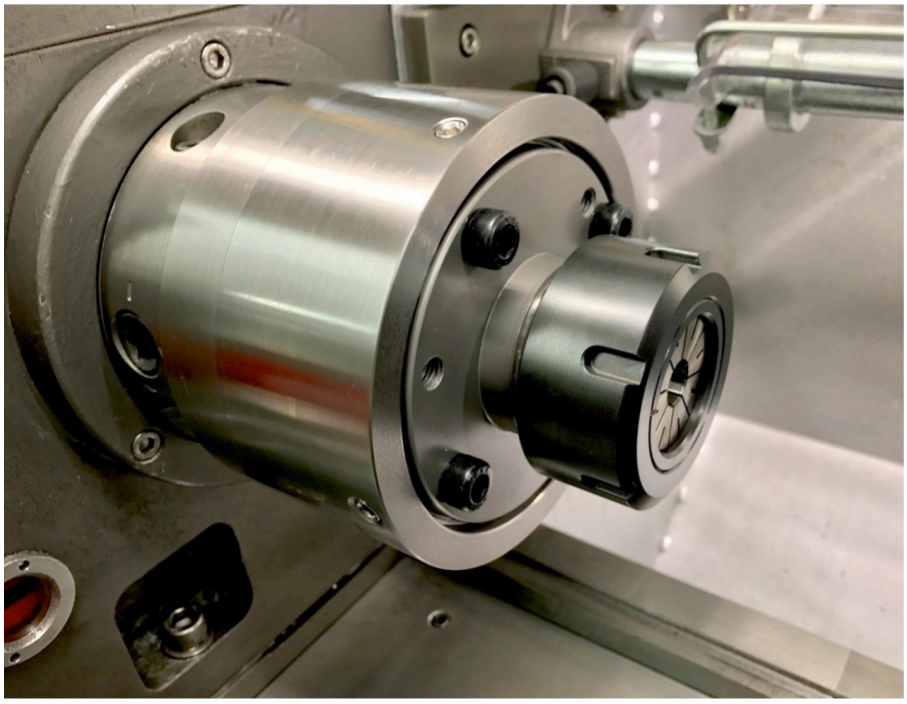
ER collets

ER collets are useful for holding BOTH tooling and workpieces. They have a clamping range of ~1mm. An ER collet is secured via a collet nut using a spanner wrench that presses the collet into the chuck's tapered hole. That same nut is designed to latch onto the collet so that the collet will be pulled out of the taper when the nut is unscrewed, thus releasing the collet's grip on the part or tool.

An ER collet is tightened and loosened at the nose of the collet chuck by turning the collet nut. When the nut is tightened, the collet compresses around the cylindrical part or tool the full length of the collet, not just at the nose-end of the part like the 5C variety discussed below. I my experience, the most critical aspects for precision ER setups is buying a very high quality ER collet nut made by Rego-Fix (the originator of the ER system in Switzerland) and high quality ER collets. This video is worth watching to understand a few of the common misconceptions about use of, and interaction between the ER collet and ER collet nut.

Below is a photo of an ER40 style collet. Note that the splits around the perimeter of the collet originate from both ends of the collet in a staggered manner. This is the means by which the collet contracts in a cylindrical manner when it is forced into the taper of a collet chuck.

On a lathe, an ER40 collet chuck mounted on the spindle can be used to hold small diameter material for machining operations. ER40 collets have a maximum capacity of 26mm, or just over 1". Shown below is my ER40 collet chuck with D1-4 backing plate, mounted on my PM1340 lathe - I made my own ER40 collet chuck setup which is documented here, or you can buy an ER40 collet chuck with D1-4 backing plate from Shars, or from other manufacturers if higher precision is required:



This is a time-laps video that illustrates the use of the ER40 collet chuck on my PM1340 lathe.

In addition to use on a lathe spindle, an ER collet chuck with an R8 or Morse taper end can be employed on a mill or lathe to rigidly hold tooling that might otherwise spin in a drill chuck - such as an end mill or other tooling or indicators with a cylindrical mounting shaft. (A drill chuck will not grip an end mill tight enough to

prevent the tool from spinning in the chuck.) The ER40 collet chuck is also a good way to hold odd-sized tooling (e.g., 8.5mm) in an R8 spindle.

This is what an ER40 collet chuck for an R8 mill spindle looks like:

This is the ER40 collet chuck with MT3 arbor end that would fit the tailstock on a lathe, or in rotary table with MT3 taper.

ER40 collet blocks are available for work holding small diameter round parts on the mill - the part is secured in the ER collet and then the blocks are then secured in a mill vise or the jaws of a conventional lathe chuck. This is one way you can hold cylindrical materials in a mill vise, and then rotate the collet block in the vise to perform successive operations that are clocked at 60°, 90°, 120°, or 180°. Shown below is a photo of a square and a hexagon ER40 collet block.

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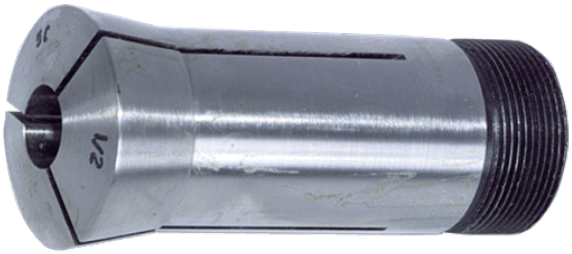
This is a video demonstrating the use of a square ER40 collet block to hold a round part in a milling vise. The part has a 3/4" round shaft secured in the ER collet, while the mill is used to drill and tap for a set screw with the collet block secured in the mill vise. A second operation rotates the collet block 180° in the vise so there are two opposing set screws around the circumference of the part being worked on.

Using a hex ER collet block is one way to take a round shaft (that's perhaps threaded on the lathe) over to the mill and machine a hex-head on the end of the shaft. The same ER40 collet blocks can be mounted in a conventional 3- or 4-jaw chuck on the lathe. This can be useful when taking the same part back and forth between the mill and the lathe, when you also need to keep the part consistently clocked (rotated) between operations on different machines.

An ER collet is secured via a nut using a spanner wrench that presses the collet into the chuck's tapered hole. That same nut is designed to click onto the collet so that the collet will be pulled out of the taper when the nut is unscrewed, thus releasing the collet's grip on the part or tool. An ER collet is always tightened and loosened at the nose of the collet chuck. An ER collet has a ~1mm clamping range - no more. And it compresses around the cylindrical part or tool the full length of the collet, not just at the nose-end of the part like the 5C variety. The most critical aspect for precision ER setups is buying a very high quality ER collet nut made by Rego-Fix (the originator of the ER system in Switzerland). This video is worth watching to understand a few of the common misconceptions about ER collet use.

5C collets

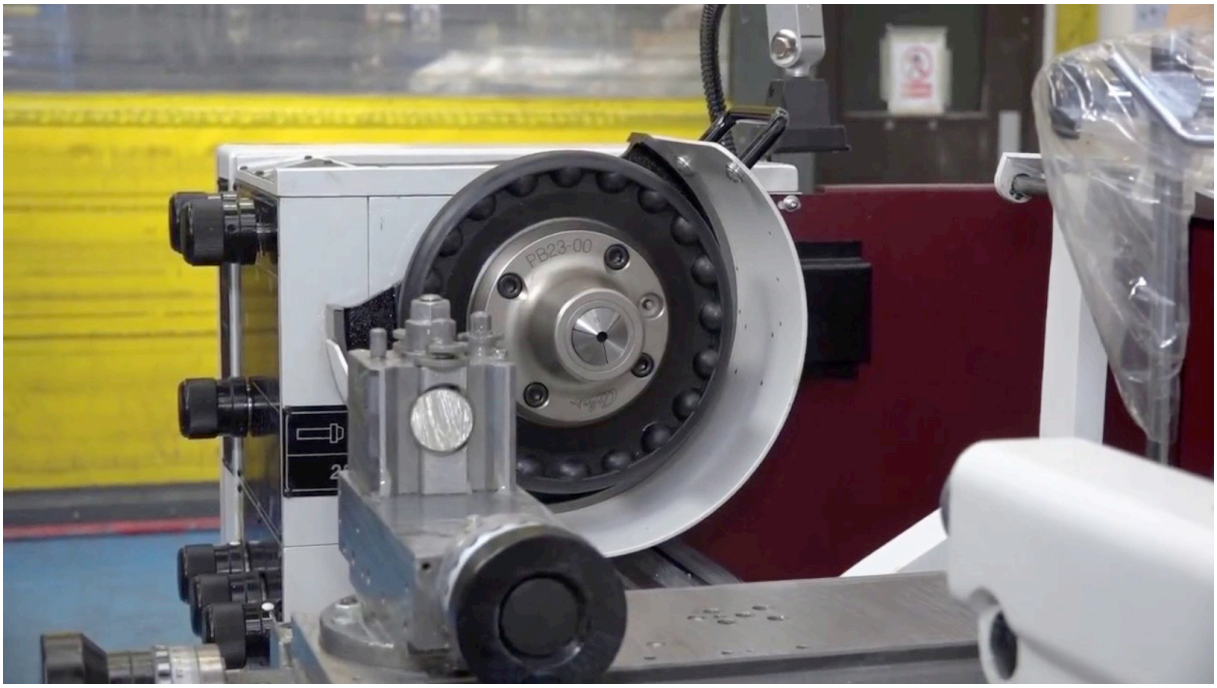
A 5C collet is only used for holding materials, not tools. It has a much smaller clamping range of a few thousandths of an inch, so you need a LOT of them to cover a 1" range. Unlike the ER collets, they only clamp on the material at the nose-end. The 5C collet does not compress cylindrically like ER collets, they pinch at the nose. This is why you need so many to cover a given range. The photo below illustrates a typical 5C collet – note that it has three splits around the perimeter, and the drawbar attachment at the small end has a male thread for use with a tube-style drawbar.



For lathe use, there are three basic types of 5C collet chucks for spindle mount. These collet chucks adapts to the lathe spindle with the same style of mounting system that's used for a 3-jaw scroll chuck on the same lathe. The spindle mount could be Camlock, threaded, tapered, or some other configuration.

The most basic type of 5C collet chuck for a lathe is one that uses a chuck key to actuate the collet closure - rotating the chuck wrench actuates a built-in threaded sleeve that pulls or pushes on the 5C collet to compress or release the collet. That type is shown in the following photo.

Similar 5C collet chucks are available for the lathe that actuate the collet closure with a large wheel on the chuck-side of the spindle. The wheel type lathe collet chuck is shown below. The large black wheel can be gripped and turned by hand (assuming you have a spindle lock on the lathe) to actuate and compress or release the 5C collet in the taper of the collet chuck.



The third type of 5C lathe collet chuck actuates the collet a quick release drawbar mechanism on the left side of the spindle. That system is called a 5C collet closer – you'll find a decent video of how it works here. With this type of setup, the collet chuck attaches to the lathe spindle in the conventional manner. The following photo is a 5C collet chuck (on the right) with the collet closure mechanism that mounts to the left side of the lathe headstock and reaches through the spindle to the 5C collet with a tube-style drawbar on a quick-release lever mechanism. The system is designed such that the lever-closing mechanism remains stationary even when the lathe spindle is turning.

There are also square and hexagonal 5C collet blocks for holding round materials in a vise and indexing them at 60° or 90° similar to the ER40 collet blocks shown above. Here is a photo of square and hex 5C collet blocks. The black cylindrical item on the right is a quick-release collet closer and the handle actuates the collet from clamped to unclamped position.

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There are special 5C collets that are essentially solid faced, not fully hardened, and can be machined to hold basically any profile you can machine into the collet - these are called “emergency” collets and are often used to hold oddball sizes of materials rather than stocking the 50+ collets you’d need to cover a ⅛-¾” range. This is a photo of one type - it is installed and clamped in a collet chuck, then the collet is machined to the required diameter with a drilling or boring operation (or a profile machined into the collet on a mill). The three pins keep the collet from fully closing when the collet is tightened and being machined, then once the collet is released, the three pins are removed so the collet can fully clamp on the workpiece it was machined to hold.

Some indexing systems, dividing heads and rotary tables are available with 5C collet chucks built into the device.

Joe Pie has produced an informative video that could be useful different collet types.

When considering the trade-offs between ER40 and 5C collet systems, I decided to standardize on the ER40 collets. As such, I have the following set of components:

- 1-26mm set of metric high precision ER40 collets
- ER40 collet chuck for the spindle on the lathe
- ER40 collet chuck with MT3 taper that fits the lathe tail stock and the MT3 taper in my rotary table
- ER40 collet chuck with R8 taper for the mill
- Square and hex ER40 collet blocks
- Rego-Fix collet nuts which improve TIR significantly

With this setup, I can hold any diameter tool or material up to 1" in the lathe spindle, the lathe tail stock, the rotary table, the mill spindle, or the mill vise.

If I were doing production of hundreds of small diameter parts on the lathe, I would prefer to have a 5C collet chuck on the lathe with the quick release closer mechanism on the left side of the spindle. But I don’t do that kind of work. And if I need to hold really oddball-shaped parts in the lathe spindle, I can do that with a 3- or 4-jaw chuck, or make my own chuck jaws that conform to the profile of the part.