



Feeling Groovy

Retaining rings are used when you need a *removable* shoulder on a shaft or cylinder to facilitate an assembly. There are two families of retaining rings: internal, which are fitted inside cylinders, and external, which are fitted to shafts. Examples of internal retaining ring uses include telescoping assemblies such as shocks and brake cylinders. In these cases the retaining ring may provide a shoulder for a rubber seal or a travel limit, or both. Other examples can be found on Rotax, Jabiru, and some VW conversions. They use internal retaining rings for wrist pin retention (other VW conversions use Teflon plugs in place of retaining rings). External retaining rings can be found on hinges, linkages, and rotating shafts. Bing carburetors use a miniature C-clip retaining ring to position the main-jet metering needle.

Retaining rings come in a variety of shapes. The most basic form is the familiar snap ring, which is a C-shaped stamping with holes in the lugs at each end for a snap-ring tool. Other styles of retaining rings, such as E-clips, flat rings, and spiral-wound rings, might sometimes be

referred to generically as “snap rings,” but it’s good practice to be specific when shopping for, or machining grooves for, a particular style ring.

Retaining rings are ridiculously simple: They snap into place and they pop off. But as is often the case with simple things, small details are exceedingly important. There are more than two dozen military (MIL-SPEC) and industrial (ANSI, SAE, and DIN) standards that define everything from materials, thickness, heat treating, and finish. Don’t worry! We’re not

making rings in the home shop, but we are concerned with machining grooves that are compatible to the retaining rings available. The specs include: minimum edge margin (the distance from the end of the shaft to the groove), groove width, groove depth, and, if specified, the corner radii (minimum and maximum). These standards, like most, have evolved over the years, no doubt with the benefit of hindsight. Adherence to them assures the installation will meet strength and reliability expectations.



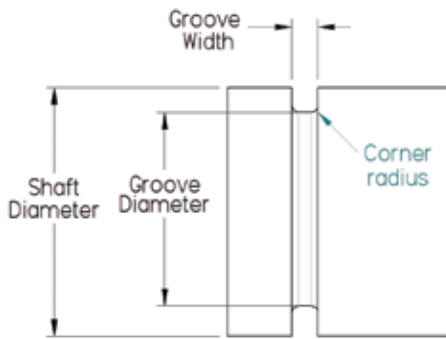
(Left) E-clips are pushed directly onto shafts and should not be confused with snap rings, which have lugged ends with eyelets for using a snap ring tool. (Right) The snap rings are shown in pairs by nominal size, with the top row external type by shaft diameter and the bottom row internal type by bore diameter.



Example of a spiral-wound retaining ring. The outward flaring wings on the ends of this 3/4-inch retaining ring indicate it’s for external (shaft) use.

Bob Hadley

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The basic details of a retaining ring groove.

A snap ring assortment is nice to have around for projects. The one I purchased did not come with any information other than which size shaft (external) or bore (internal) the rings fit. It's up to the end user to measure the thickness of each ring and cross reference the dimensions to come up with the relevant groove specs. *Machinery's Handbook* (Industrial Press, about \$80 on Amazon) has a chapter dedicated to retaining rings, including charts of the common standards. A Google search will turn up the same information, but it may take some browsing to find the exact ring.

Tooling for groove making can be bought from various tool suppliers (KB Tools, Enco, etc.), or you can grind your own from blanks. I have two Micro 100 "right-hand retaining ring bore grooving tools" (0.030-inch width groove and 0.064-inch width groove) that I purchased



Micro 100 solid carbide retaining ring grooving tools. The top tool makes a groove 0.064 inch wide and the bottom makes a groove 0.030 inch wide.

for about \$10 each on Amazon. With these two tools, I can make both internal and external grooves for all but the smallest (less than $\frac{3}{8}$ inch) retaining rings.

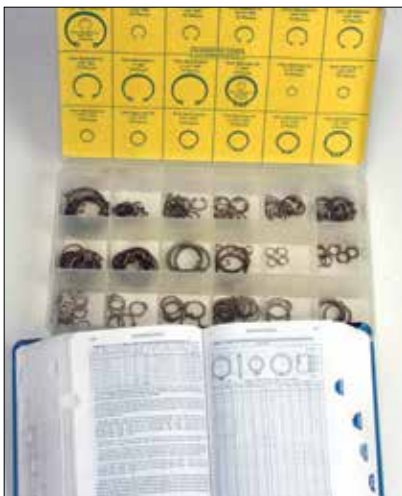
The Micro 100 tools shown are, as previously mentioned, bore grooving tools and are positioned on the lathe and tool holder like a boring bar. For

internal grooves, the part is turned "normally" (rotating counter-clockwise) with the tool plunged in straight to the desired groove diameter. For external grooves, instead of investing in separate "face" grooving tools, I simply use the bore grooving tools, but with the lathe turning "backwards" (clockwise) and the tools presented at the 3-o'clock position instead of 9 o'clock. Again, the procedure is to plunge in straight to the desired groove diameter.

I use the 0.030-inch grooving tool to make grooves up to 0.060-inch wide. Grooving tools are designed for plunging, so to make a 0.039-wide groove, for example, with the 0.030-wide tool, first make the initial groove, retract the cutter, move the carriage 0.009 inch, and then plunge again to the groove diameter



Illustrating the tool position and spindle rotation for using a bore grooving tool for both outside (left) and inside (right) grooving.



An assortment of snap ring sizes is handy to have around the shop. Refer to *Machinery's Handbook* (or search online) for the reference data necessary to machine compatible grooves.



Turning a groove and testing the fit of a $\frac{3}{4}$ -inch internal snap ring.



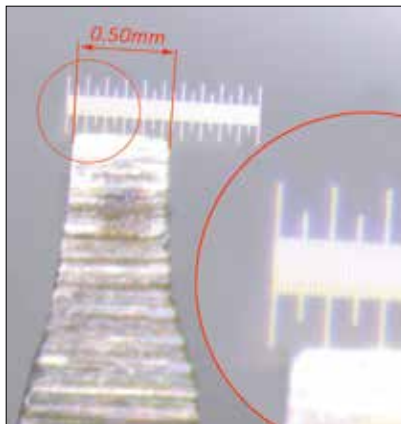
(Left) Turning an external groove with the Micro 100 tool. Note the spindle rotation is clockwise. (Right) Testing the fit of a 1-inch external snap ring.

(0.030-inch cutter + 0.009-inch offset = 0.039-inch wide groove).

Since the cost to purchase a 0.020-inch wide grooving tool was around \$60, to make the 0.020-inch wide groove for the 1/8-inch (0.016-inch) wide E-clip shown at the opening of this column, I decided to grind a homemade face grooving tool (as opposed to the Micro 100 bore-style grooving tools) from a 1/4-inch high-speed-steel tool blank. The coarse wheel on my bench grinder (see "Daily Grind," September 2017) made quick work of roughing away 90% of the shape. I did a final grinding to a width of about 0.022 inch with the fine wheel. After that, I used a plastic-handled, medium-grit EZ-LAP diamond hone to slowly creep up to the final width of .020 inch. I then used a fine-grit EZ-LAP to hone the cutting faces and ever so slightly round over the corners.

Final Thoughts

Make sure your tool is dead on center so that your machining depths are accurate.



(Left) A peek of the tool tip under the microscope with a measuring slide (the ruler-style graduations) shows that hand grinding a grooving tool can yield reasonably accurate tools. The width is 0.5 millimeter (0.019 inch). Note the red circle (enlarged view) clearly shows the corner radius. (Right) Using the tool to make a groove for the 1/8-inch E-clip.



If the snap ring floats or rotates freely in the groove, something is wrong. Either the groove is too deep or the ring has been stretched out or otherwise damaged.

Retaining rings of any type that have been removed from service or show signs of being overstretched or over-squeezed, should be replaced. Likewise,

discard and replace any snap ring that has been scratched from use or abuse, such as the tool slipping out and scarring the finish. This is especially important for piston engine wrist pin retaining clips, which are subject to extreme loads. If there are factory instructions for proper facing and orientation, follow them. ±

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