5 – MILLING THE FORK CROWN

ABOUT THIS CHAPTER

Milling the fork crown consists of two procedures. One is facing, which cuts the surface that the headset crown race sits on so that the surface is flat and perpendicular to the axis of the fork column. The other is counter-reaming, which is to cut the outside diameter of the fork-column base to change the fit of the fork-crown race.

Counter-reaming can be done without facing, but facing cannot be done without counter-reaming.

GENERAL INFORMATION

TERMINOLOGY

Counter-reaming: To reduce the outside diameter of a cylinder. In this case it is specific to the fork-column base where the fork-crown race fits.

Counter-reamer: A cutting tool that reduces the outside diameter of the fork-column base. The cutter teeth that do the counter-reaming also do the facing.

Facing: With regard to milling a fork crown, facing means to cut the top surface of the crown-race seat, so that the crown-race seat is flat and precisely perpendicular to the axis of the fork column.

Facer: The cutter that is used during facing. The teeth that do the facing also do the counter-reaming, also called a facing mill.

Fork crown: The large joining piece between the base of the fork column and the top of the fork blades.

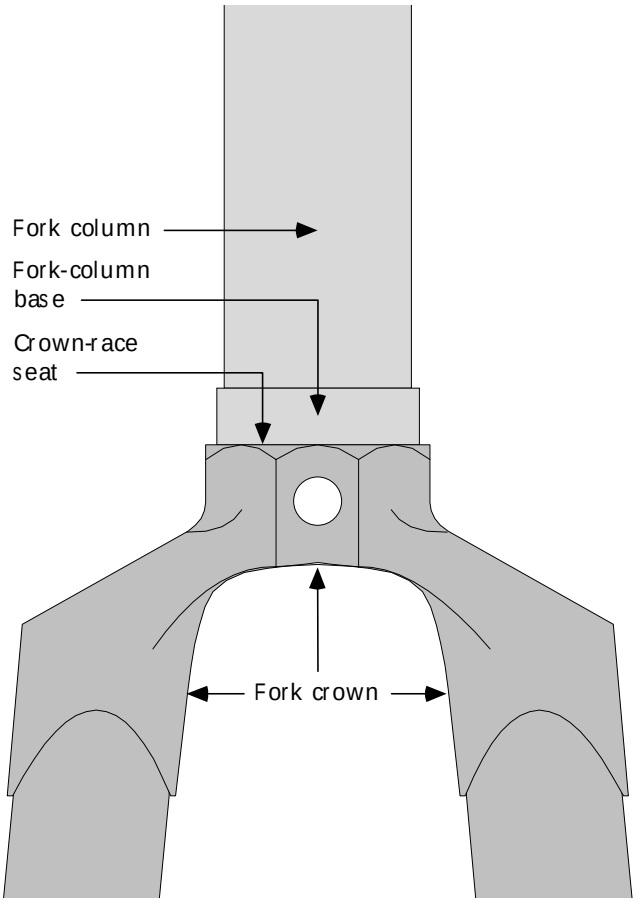
Fork column: The tube on top of the fork that goes inside the frame's head tube.

Fork-column base: The largest diameter portion of the fork column at its absolute bottom. The fork-crown race presses onto the fork-column base.

Crown-race seat: The top surface of the fork crown that the fork-crown race sits on.

Fork-crown race: The bottom piece of the headset, which presses onto the fork-column base. The fork-crown race is sometimes called the crown race.

Crown race: See fork-crown race.



5.1 *Parts of the fork.*

Pilot: The main body of the counter-reaming/facing tool. Some counter-reaming/facing tools have a hole through the body that acts as the pilot, and some counter-reaming/facing tools have an insert that is held in place by a set screw. The inserts can be changed to accommodate different sizes of fork columns.

1" fork: A fork column with a diameter of approximately 1". Headsets of several press-fit standards fit 1" forks.

1–1/8" fork: A fork column with a diameter of approximately 1–1/8". Headsets called 1–1/8" fit these forks.

1–1/4" fork: A fork column with a diameter of approximately 1–1/4". Headsets called 1–1/4" fit these forks.

PREREQUISITES

Stem removal and installation

In order to counter-ream or face the fork, the headset and fork must be removed. The stem must be removed before counter-reaming/facing can begin. At the completion of the job the stem will need to be replaced. If you are unfamiliar with stem removal and installation, see the **HANDLEBARS, STEMS, AND EXTENSIONS** chapter. In some cases the brake cable or front brake may need to be detached, or removed completely, in order to remove the stem.

Headset removal and installation

In order to counter-ream or face the fork, the headset and fork must be removed. At the completion of the job, the headset and fork will need to be replaced. If you are unfamiliar with these procedures see the **HEADSETS** chapter.

INDICATIONS

Symptoms indicating need of counter-reaming

One likely reason that a fork should be counter-reamed is that a JIS dimension headset has been removed and the replacement headset is of a different fit standard. Another likely reason is that a replacement fork is being installed that has a fork-column-base diameter that is too large for the existing fork-crown race.

Symptoms indicating need of facing

There is only one symptom that indicates a need for facing the crown-race seat. When attempting to adjust new, high-quality headsets, a condition becomes apparent in which the headset feels smooth through a portion of its rotation and tight in another portion of its rotation. This is called a tight/loose pattern. The tight/loose pattern can be caused by things other than a crown-race seat that needs facing, such as: low precision parts, worn out parts, bent fork column, head tube that needs facing, and mis-installed head-tube races or crown race. When a fork crown needs facing, it is due to poor quality of manufacturing, not abuse or wear.

When the head tube has been faced to eliminate a tight/loose pattern, the job is not complete until the crown-race seat has been faced as well.

Other reasons for facing the crown-race seat

Facing the crown-race seat is cheap insurance to enable easy adjustment of the headset and maximize parts longevity. For this reason, some shops will routinely counter-ream and face forks on higher priced bikes.

In the case that a shop sells framesets bare, it is good marketing technique to face forks before putting them out for display. Knowledgeable customers will look for whether facing has been done to evaluate whether the frame has been properly prepped for assembly.

TOOL CHOICES

The fit dimension of the headset crown race and the fork-column diameter are what determines what tool will be needed. The following list (table 5-1, page 5-2) covers all tools for the job. The preferred choices are in **bold**. A tool is preferred because of a balance among ease of use, quality, versatility, and economy. When more than one tool for one function is **bold**, it means that several tools are required for different configurations of parts.

All dimensions are in millimeters because these are the only units used by manufacturers.

TIME AND DIFFICULTY

Milling the fork column is a job of moderate difficulty that takes approximately 10 minutes on a bare fork.

COMPLICATIONS

Multiple 1" fork-column standards

The traditional 1" fork-column size has multiple standard dimensions for the fork-column base. They are as follows:

26.5mm: Traditional size associated with Campagnolo and other professional quality headsets. Virtually all quality replacement headsets for 1" forks require this dimension.

26.6mm: Common to most Peugeot bicycles made in France, this size is close to, but not interchangeable with, the 26.5mm size. The counter-reamer for this dimension is required whenever installing a replacement fork on a Peugeot while keeping the original headset. This size counter-reamer is not needed if the customer is willing to always install new headsets with new forks on Peugeots.

27.1mm: Common to all Taiwanese and Japanese original equipment and replacement forks. This size counter-reamer is needed if this size fork is to be faced without having to change the headset.

Numerous others: Other sizes periodically pop up on obscure brands from Europe and American-made discount store bicycles. Counter-reamers are not available, so converting to the next smaller common size is the usual option.

Bulge-base and oversized-fork columns

The counter-reamer body has a close tolerance hole for the fork column. Some fork columns are fatter than the standard that some counter-reamer pilots will not clear.

Suspension forks are the most common forks with bulged bases, but these are not much of a problem because their un-welded fabrication process allows greater precision during manufacturing.

Aluminum and carbon fiber forks often have a fatter fork column than normal. These forks may need counter-reaming or facing and the VAR 963 is the only tool that will fit.

Heavy build-ups of chrome or paint can also cause interference with the counter-reamer pilot. There is nothing that can be done about chrome, but paint can be sanded off with patience.

Titanium

Titanium has completely different metallurgical characteristics than steel or aluminum. It is necessary for the counter-reamer and facer to be designed in a dramatically different way to be suitable for counter-reaming and facing titanium. Once a counter-reamer/facer is designed to be suitable for titanium it will no longer be suitable for other materials. Special facers for titanium may become available, but whether enough titanium forks will be encountered that need counter-reaming and facing is a significant question.

Aluminum

Aluminum is a perfectly suitable material for counter-reaming and facing, but presents some special concerns to the mechanic. *The type of cutting oil used is critical.* There are cutting oils made specifically for use on aluminum. Any cutting oil that is suitable will specify for use on aluminum on the container. Words like "all-purpose" and "multi-purpose" should not be interpreted to mean: includes aluminum.

Chrome-plating

Using a counter-reamer or facer on a chrome-plated fork crown will also dull it quickly. Facing a chrome-plated fork crown is very difficult to do, with the facer failing to get a bite at normal pressure. This job can be done with extremely high cutting pressure, but it is strongly advised against.

Chrome-plated crown-race seats should not be faced unless the chrome is first removed, a potentially difficult procedure. A file or grinding stone can be used for chrome removal. Counter-reaming can be done without facing, but it wears the tool severely.

FORK-COUNTER-REAMING/FACING TOOLS (table 5-1)

Tool	Fits and considerations
Bicycle Research FCS	Complete counter-reaming/facing tool with 26.5mm, 30.1mm, and 33.1mm counter-reamers
Bicycle Research FC2	Additional 27.1mm counter-reamer required if using Bicycle Research FCS to face 1" fork column with JIS dimensions
Campagnolo 718	Complete counter-reaming/facing tool with 26.5mm counter-reamer for 1" fork column
Campagnolo 718/8OS	Complete counter-reaming/facing tool with 30.1mm counter-reamer for 1–1/8" fork column
VAR33AC (w/26.6 & 27.1 mills)	Complete counter-reaming/facing for JIS and French 1" fork columns
VAR 38D/4E	Additional 26.5mm & 27.2mm double-sided cutter needed for 1" fork columns if not using VAR 963C or Bicycle Research FCS, which include critical 26.5mm size
VAR 963C	Complete counter-reaming/facing tool with 26.5mm, 30.1mm, and 33.1mm counter-reamer (least interference w/ bulge-based fork columns of all models)
VAR 965	Complete counter-reaming/facing tool for 1–1/4" fork columns
VAR 966	Complete counter-reaming/facing tool for 1–1/8" fork columns

Incomplete counter-reaming

After completing the counter-reaming and facing, it may appear that the counter-reaming was not completed because the counter-reamer has not left a 360° cut. This is normal and happens because the fork-column base is off-center to the axis of the fork column. In fact, in this case the counter-reaming that has occurred may be excessive.

Excessive counter-reaming

After using the correct counter-reamer, the fork-crown race may end up fitting loose. This usually occurs when an off-center fork-column base that did not actually need counter-reaming has been counter-reamed. The counter-reamer removes metal at the high points so that the average outside diameter is reduced when it was not required. There is no simple way to avoid this, except to eliminate paint when it causes the pilot to fit too closely. When excessive counter-reaming happens, the fork-crown race will need to be installed with Loctite RC680.

Excessive counter-reaming time

Most fork-column bases have already been counter-reamed to close to the correct size before the mechanic ever sees them. Using a counter-reamer on one of these will be a very quick process. On the other hand, the counter-reamer is sometimes used to convert a fork-column base from a 27.1mm size to a 26.5mm size. When using a counter-reamer to make this conversion, instead of simply to improve an existing fit, then expect it will take 5–10 extra minutes to cut this much metal.

Unusable tension devices

It is not unusual for the fork-column length to be too short or too long to use a tension device on the counter-reaming tool. This is not a problem, and the procedure can be done easily without the use of a tension device.

CARE OF COUNTER-REAMING AND FACING TOOLS

Counter-reaming and facing tools are very expensive and easily damaged. Proper cutting technique is important to get good life from them, but that is not all. When storing counter-reamer/facers make sure they are clean and coated with oil. The cutting edges are easily chipped by light impact with other metal objects, so handle them and store them in a way that this will not happen. On hooks on a pegboard is a good way to store facing tools.

When cleaning counter-reamers and facing tools use a brush and solvent. Blowing them clean with compressed air is not damaging to the cutting edges but is dangerous because of flying metal debris. Coat the cutter with a light oil after cleaning and drying.

COUNTER-REAMER SIZE REQUIREMENTS

The I.D. of the fork-crown race that will be pressed onto the fork-column base determines the correct size of counter-reamer to use. If replacing the headset, be sure to measure the new headset. *Do not measure the O.D. of the fork-column base to determine the counter-reamer size.*

Measure the I.D. of the fork-crown race (see figure 5.2) that will be pressed onto the fork-column base, find the range that includes this measurement in the **Race I.D.** column in table 5-2, and look to the right in the **Counter-reamer size** column in table 5-2 to determine the correct size to use.

All dimensions are in millimeters because these are the only units used by manufacturers.

COUNTER-REAMER SIZES (table 5-2)

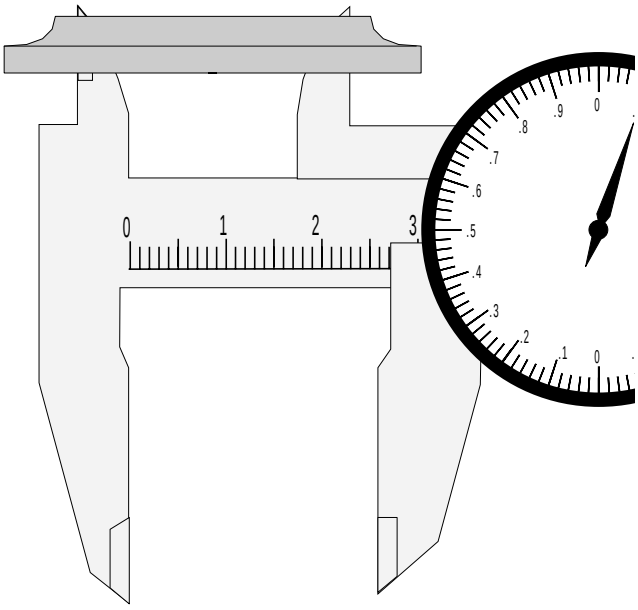
Race I.D.	Counter-reamer size
26.30–26.40mm	26.5mm
26.41–26.50mm	26.6mm
26.90–27.00mm	27.1mm
29.90–30.00mm	30.1mm
32.90–33.00mm	33.1mm

FORK COUNTER-REAMING AND FACING PROCEDURE

Fork counter-reaming and facing can be done at the same time with a single tool, or counter-reaming can be without facing (depending on the desire for facing). Only one procedure is described here, despite the above-mentioned choices, because the difference in the required procedure for each choice is minimal. This procedure is written on the assumption that counter-reaming and facing will be done at the same time. If counter-reaming only, simply stop the procedure when the counter-reaming has been completed.

All dimensions are in millimeters because these are the only units used by manufacturers.

1. [ ] Use appropriate procedure/worksheet to remove headset and fork.



5.2 *Measuring the fork-crown race to determine the correct counter-reamer size.*

2. [ ] Measure I.D. of fork-crown race to be installed and record here: _____mm.

Some sizes of fork-crown races are extremely close without being interchangeable. Measurement to the nearest .05mm is required.

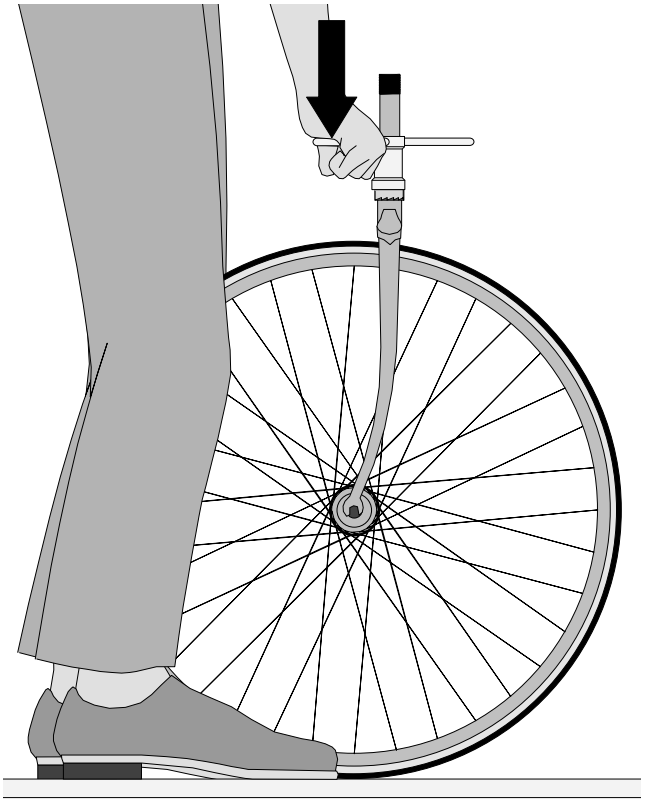
3. [ ] Look up appropriate counter-reamer dimension on COUNTER-REAMER SIZES table 5-2 and record here: _____mm.

The only way to determine the size of some counter-reamers is to measure the I.D. with a caliper. This is particularly true when determining the size of VAR double-ended counter-reamers, which are marked with two sizes, but are not marked as to which end is which size.

4. [ ] Check or install correct size counter-reamer on tool.

There are two good ways to hold the fork while doing the procedure.

The simplest way is to mount the fork on a quick release front wheel (it's best to have an old dead wheel around just for this purpose). Stand facing the front of the fork. With the wheel on the floor, stand straddling the front of the wheel to stabilize it. Lean over the fork and wheel to use the tool and apply cutting pressure.



5.3 *Using a wheel to hold a fork that is being counter-reamed and faced.*

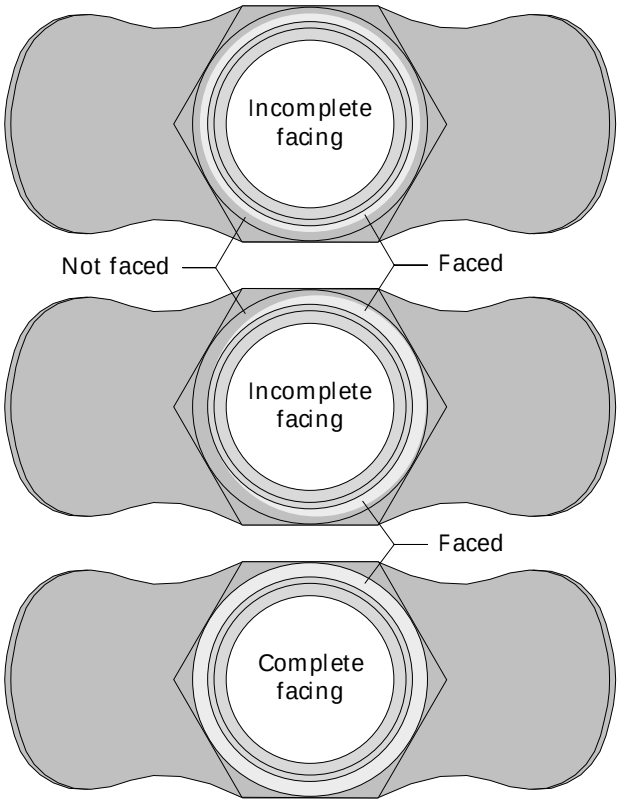
Another very effective method for holding the fork is to salvage any old quick release hub and use some sort of metal straps to secure it to the middle of a 2' × 2' piece of plywood or chip board. Clamp the fork (standing straight up) to the hub and lean over the fork to operate the tool and apply cutting pressure. This system is more stable than the wheel mounting system, but requires bending over further.

5. [ ] Mount fork on front wheel or fork platform (see explanatory notes).

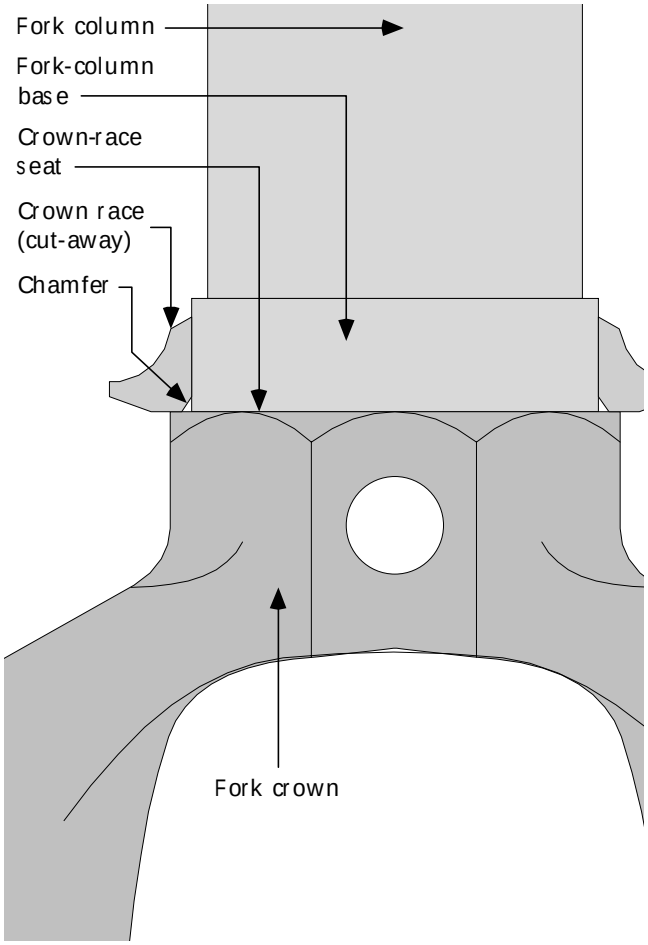
Cutting oil is vital to the quality of the cutting and the life of the cutting tools. Apply oil liberally when starting and as you continue to cut. Use oil labeled for use on aluminum when cutting aluminum.

6. [ ] **Apply ample cutting oil to crown-race seat and counter-reamer.**
7. [ ] **Place tool on fork column.**
8. [ ] **With weight on handles, turn tool clockwise several full turns.**
9. [ ] **Pull tool up to check progress of counter-reaming or facing.**
10. [ ] **If counter-reaming only, repeats steps 6–10 until fork-column base is counter-reamed fully at outer perimeter.**

With bottom bracket and head-tube facing, the only factor determining whether the facing is completed is whether fresh metal has been cut for a full 360°. The nature of the fork-crown race requires that this complete 360° cut be at the outer perimeter of the crown-race seat or it may be ineffective. A continuous 360° cut adjacent to the fork-column base, but not complete all the way around the outer perimeter of the crown-race seat, will not do the job. This is because many fork-crown races have a chamfer on the inner perimeter of the bottom face of the race (see figure 5.5). If the cut portion of the crown-race seat does not extend beyond the diameter of this chamfer, then the fork-crown race may not be sitting on faced surface at all.



5.4 *Face the crown-race seat until there is a complete 360° cut at the outer perimeter of the crown-race seat.*



5.5 *The chamfer at the inner edge of the bottom face of the crown race makes it necessary to face the crown-race seat all the way to the outer perimeter of the crown-race seat.*

11. [ ] **If facing, repeats steps 6–11 until facing cut is a complete 360° at outer perimeter of crown-race seat.**
12. [ ] **Remove tool from fork.**
13. [ ] **Remove fork from front wheel or from fork platform.**
14. [ ] **Clean fork and tool.**
15. [ ] **Use appropriate procedures/worksheets to install fork, headset, and stem as necessary.**