4 – REAMING AND FACING THE HEAD TUBE

ABOUT THIS CHAPTER

This chapter is about two head-tube milling procedures: reaming the head tube, and facing the head tube. Reaming the head tube is done to improve, or change, the fit of a headset pressed-race into the head tube. Facing the head tube is done to improve the alignment of a headset pressed-race. Improving the alignment of the headset parts improves the quality of the adjustment and the longevity of the parts.

GENERAL INFORMATION

TERMINOLOGY

Reaming: To enlarge the diameter of a hole.

Reamer: A cutting tool that enlarges the inside diameter of a hole.

Facing: To cut the end of a cylinder (the head tube in this case) so that it is flat and precisely perpendicular to the axis of the cylinder.

Facer: The cutting tool that is used to face the head tube, also called a facing mill.

Head tube: The near-vertical frame tube at the front of the frame in which the fork column rotates.

Pilot: There are two different pilot systems for a headtube reaming/facing tool. There is always a conical pilot insert that goes into the end of the tube not being reamed or faced. This pilot keeps the tool shaft centered in the head tube. In addition to this pilot, there may be a pilot built into the cutting end of the tool. This other pilot may be below the reamer or below the facer in place of the reamer. In either case, the pilot that is built into the cutting end of the tool should be a close fit to the inside diameter of the head tube.

1" headset: A headset that fits on a fork column with a diameter of approximately 1".

1–1/8" headset: A headset that fits on a fork column with a diameter of approximately 1–1/8".

1–1/4" headset: A headset that fits on a fork column with a diameter of approximately 1–1/4".

PREREQUISITES

Stem removal and installation

Before removing the headset and fork, the stem must be removed. After the head tube has been reamed or faced, and after the headset has been installed, the stem will need to be installed. If 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 at some point, or removed completely, in order to remove the stem.

Headset removal and installation

In order to ream or face the head tube, the headset and fork must be removed. After the head tube has been reamed or faced, the headset and fork need to be reinstalled. If unfamiliar with these procedures, see the **HEADSETS** chapter.

INDICATIONS

Symptoms indicating need of reaming

The most likely reason that a head tube must be reamed is that a JIS dimension headset (a headset made to Japanese industrial standard race dimensions of 30.0mm and 27.0mm) has been removed, and the replacement headset is of a different fit standard. It is possible, however unlikely, that a head tube will deviate so much from the ideal dimension that a correctly fit headset will be too difficult to press in. In this case, reaming will be required to improve the fit.

Symptoms indicating need of facing

There is only one symptom that indicates the need for facing the head tube. When attempting to adjust a high-quality cup and cone headset with new parts, the fork 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 also be caused by conditions other than a head tube that needs facing, such as: low precision parts, worn out parts, a bent fork column, a crown race seat that needs facing,

and mis-installed cups or crown race. When a head tube needs facing, it is due to poor quality of manufacturing, not abuse or wear.

Other reasons for facing the head tube

Facing the head tube is cheap insurance to enable easy adjustment of the headset and maximize parts longevity. On higher priced bikes some shops will routinely ream and face head tubes.

In the case that a shop sells framesets bare, it is good marketing technique to face them 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 dimensions of a pressed head-tube race are what determines what tool is required. The following list (table 4-1) covers all the tools available for reaming and

HEAD-TUBE REAMING/FACING TOOLS (table 4-1)

Tool	Fits and considerations
Bicycle Research HT1	Complete reaming/facing tool with 30.0mm reamer
Bicycle Research HT1/4	Additional 29.8mm reamer required if using Bicycle Research HT1 to face head tube with JIS dimensions
Bicycle Research HR3	Additional 33.8mm reamer required if using Bicycle Research HT1 to face head tube with 1–1/8" oversize headset
Bicycle Research HT1	Additional 36.8mm reamer required if using Bicycle Research HT1 to face head tube with 1–1/4" oversize headset
Campagnolo 733	Complete reaming/facing tool with 30.0mm reamer, cannot be used to face JIS head tube
Campagnolo 7185016	Additional 33.8mm reamer required if using Campy 733 to face head tube with 1–1/8" oversize headset
Fisher 15	Additional 36.8mm reamer required if using Campy 733 to face head tube with 1–1/4" oversize headset
Park HTR-1	Complete reaming/facing tool w/30.0mm reamer, includes all necessary pilots to face head tubes, instead of requiring additional 29.8mm, 33.8mm, and 36.8mm reamers
Park 754	33.8mm reamer for Park HTR-1, only needed if preparing head tube at frame manufacturing level
Park 755	36.8mm reamer for Park HTR-1, only needed if preparing head tube at frame manufacturing level
VAR 32C	Complete reaming/facing tool with 30.0mm reamer
VAR 968	Additional 33.8mm reamer required if using VAR 32C to face head tube with 1–1/8" oversize headset
VAR 969	Additional 36.8mm reamer required if using VAR 32C to face head tube with 1–1/4" oversize headset
VAR 970	Oversize facer for VAR 32C required to face head tube with 1–1/4" oversize headset
United Bicycle Tool 32BUSH/8	Bushing required if using VAR 32C to face head tube with 1–1/8" oversize headset instead of more expensive VAR 968
United Bicycle Tool 32BUSH/4	Bushing required if using VAR 32C to face head tube with 1–1/4" oversize headset instead of more expensive VAR 968

facing the head tube. The preferred choices are in **bold**. A tool is preferred because of a balance among: ease of use, quality, versatility, and economy.

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

TIME AND DIFFICULTY

Reaming and facing the head tube is a moderately difficult job that takes 15–25 minutes on a bare head tube.

COMPLICATIONS

Whether to use a reamer or a pilot

Some tools give you a choice between using a reamer or just a pilot on the reaming/facing tool. You *must* use a reamer if converting the head tube from one size standard to another. Otherwise the reamer is probably not required and a pilot will do.

When not converting the size, the decision can be made by trial and error, or measurement. To make the choice by trial and error, test install the headset pressed races with proper technique and tools (see page 11-16). If the headset pressed-races are unusually difficult to install, stop and remove them. Reaming is required.

To determine if reaming is required by measurement, use the **REAMER & PILOT SIZES** table 4-2 (page 4-5) to determine the correct reamer size, then take two inside diameter measurements of the head tube (90° apart) and average the two measurements. If the average of the two measurements is less than the recommended reamer size by .05mm or more, reaming is required.

Titanium

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

Aluminum

Aluminum is a perfectly suitable material for 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 suitable for use on aluminum will say so on the container. Do not interpret words such as "all purpose" and "multi-purpose" to mean: includes aluminum.

Chrome plating

Chrome-plated head tubes cannot be faced unless the chrome is first removed, a potentially difficult procedure. A file or grinding stone can be used for chrome removal. Reaming chrome head tubes can be done without facing, but severely wears out the reamer.

Failure of VAR pilot to install fully

Stock VAR pilots (fat shaft below the reamer) can be too fat and/or too long for many head tubes. If the pilot is too fat, it will interfere with any imperfection in a head tube, including a tube seam. The stock VAR pilot is too long for very short head tubes and interferes with the conical pilot at the other end of the head tube. United Bicycle Tool Supply has modified the VAR bushing to a trouble-free length and diameter. This modified bushing is available separately (VAR-971/3), but it is the stock bushing on all VAR 32C reamer/facers sold by United Bicycle Tool Supply.

Incomplete reaming

After completing the reaming and facing, it may appear that the reaming was not completed because the reamer has not left a 360° cut. This is normal and happens because few head tubes are truly round; in fact, in the case of 360° of clean metal on the inside of the head tube, the reaming that has occurred may be excessive.

Excessive reaming

Even after using the correct reamer, the headset part may end up fitting loose. This usually occurs when an out-of-round head tube that did not actually need reaming has been reamed. The reamer removes metal at the low points so that the average inside diameter is increased when it was not required. An out-of-round head tube will become round when the head-tube race is installed. Out-of-round head tubes are not a problem. Avoid excessive reaming by using the Park HTR-1 (with stock pilots) or VAR 32C (with custom United Bicycle Tool pilots) when facing an out-of-round head tube that has an acceptable average inside diameter.

Excessive reaming time

Most head tubes have already been reamed to close to the correct size before the mechanic ever sees them. Using a reamer in one of these will be a very quick process. On the other hand, the reamer is sometimes used to convert a head tube from a 29.8mm hole size to a 30.0mm

hole size. When using a reamer to make this conversion, instead of simply to improve an existing fit, expect reaming to take 5–10 minutes extra.

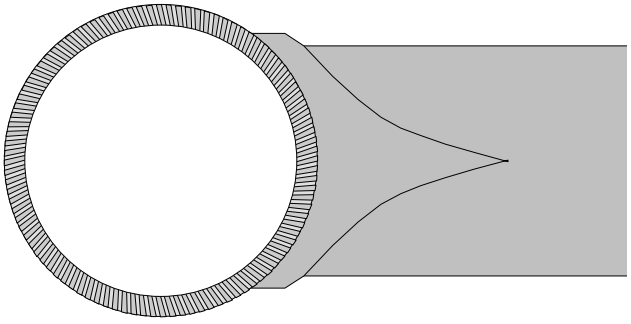
Facer interference with down tube

Avoid certain combinations of large diameter facers (suitable for bikes that use 1–1/4" headsets) with head tubes that do not extend very far below the bottom side of the down tube. This combination of wide facer and short head tube may result in the facer cutting into the down tube or down tube lug/joint. *This will destroy a frame!*

NOTE: When facing the bottom end of every head tube, check that there is adequate clearance between the facer and the down tube or down tube lug/joint.

Facing tool chatter

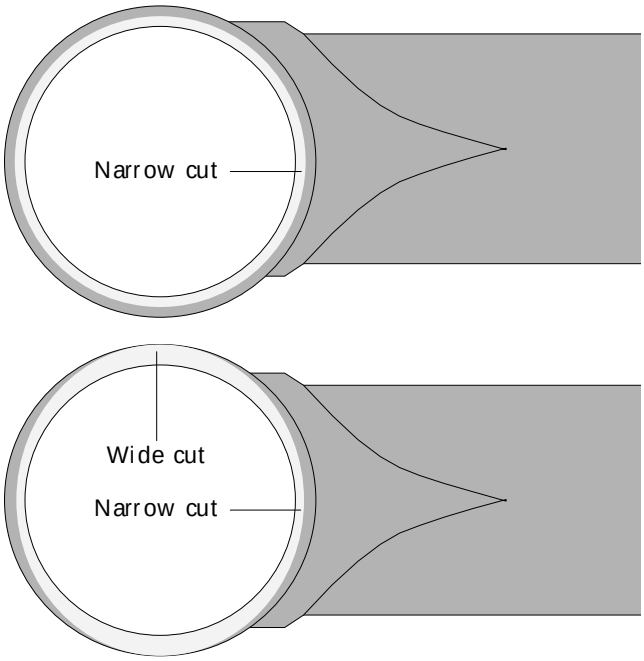
Facing tool chatter is the tendency of the facing tool to bite and jump at rapid frequency. This tendency leaves a series of radial lines in the face of the head tube. These radial lines are a cosmetic flaw, not a mechanical flaw. To some degree the chatter marks are preventable, but circumstances outside the control of the mechanic make make chatter marks unavoidable at times. Proper facing technique can reduce the likelihood of chatter occuring, but if the type and hardness of the head-tube material is not compatible with the design of the facing tool, then chatter cannot be prevented. In the facing procedures there are detailed instructions of the technique that reduces the likelihood of chatter occuring. See figure 4.1 below.



4.1 *The radial lines in the face of this shell are the result of chatter.*

Uniform width of cut

When facing a head tube, the objective is to complete a cut that is a full 360° around the face of the head tube. Sometimes, once the 360° cut is achieved, the cut is not a uniform width; in fact, the cut may be very narrow at points, and not near as wide as the head-tube face. There is a tendency to conclude that more facing is needed when this occurs. It is not a mechanical necessity to achieve a uniform, full-width cut; the only reason to attempt to create a uniform, full-width cut is to improve the cosmetics. It may take several extra minutes of work to achieve a cosmetically-superior facing cut. If the appearance of the cut can be substantially improved by working 1–2 extra minutes, fine; otherwise, leave the cut with a non-uniform width, as long as it is a full 360°. See figure 4.2.



4.2 *As long as the facing cut is a full 360°, it does not matter if the cut is narrow, or not a uniform width. Both the head-tube faces shown here are acceptably faced.*

CARE OF REAMING AND FACING TOOLS

General tool care

Reaming and facing tools are very expensive and easily damaged. Proper cutting technique is important to ensure good life, but that is not all. When storing reamers and 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 reaming and facing tools.

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

Reaming and facing chrome-plated head tubes

Using a reamer or facer on chrome-plated head tubes will dull the tool quickly. Reaming and facing a chrome-plated head tube is impossible because the facer fails to get a bite at normal pressure. With very high cutting pressure reaming and facing the head tube can be done in some cases, but it is strongly advised against. Try using a file to remove chrome from the face of the head tube.

REAMER AND PILOT SIZE REQUIREMENTS

The outside diameter of the inserted portion of the headset race, which will be pressed into the head tube, determines the correct size of reamer or pilot to use. If replacing the headset, be sure to measure the new headset. *Do not measure the inside diameter of the head tube to determine the reamer/pilot size.* This measurement is only needed in order to determine whether to use a reamer or a pilot.

Measure the diameter of the inserted portion of the race that will be pressed into the head tube (see figure 4.3), find the range that includes this measurement in the **Race insert O.D.** column of table 4-2 below, then look to the right in the **Reamer size** or **Pilot size** columns to determine the correct size to use.

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

REAMER & PILOT SIZES (table 4-2)

Race insert O.D.	Reamer size	Pilot size
29.95–30.10mm	29.8mm	29.75mm
30.15–30.30mm	30.0mm	29.95mm
32.65–32.80mm	32.5mm	none available
33.95–34.10mm	33.8mm	33.75mm
36.95–37.10mm	36.8mm	36.75mm

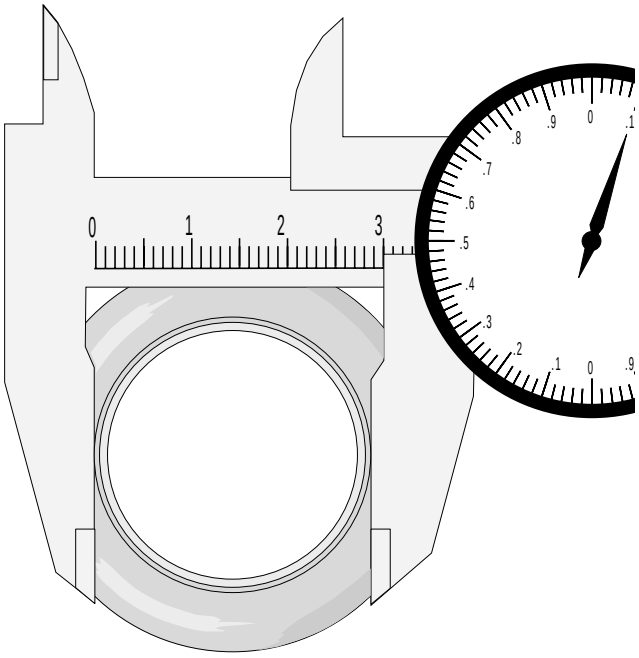
HEAD-TUBE REAMING AND FACING PROCEDURE

Head-tube reaming and facing can be done at the same time with a single tool, or facing can be done without reaming, depending on the tool used. It is theoretically possible to ream without facing, but pointless to do so. 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 reaming and facing will be done at the same time. If facing is the only procedure done (with a suitable brand of tool), simply substitute the correct-size pilot for the correct-size reamer, and skip the procedure that says to apply cutting oil to the reamer.

If the head tube being faced has clean raw metal showing on the face, it can be difficult to track facing progress. In this case, use a material called machinist's dykem (available from a general tool supply or from a machinist's supply) to paint the head-tube face before proceeding.

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

1. **[ ] Use appropriate procedure/worksheet to remove headset and fork.**
2. **[ ] Measure O.D. of inserted portion of race to be pressed into head tube and record measurement here: _____mm.**



4.3 *Measure the O.D. of the inserted portion of the race in this way to determine the appropriate reamer/pilot size.*

Use the measurement you have just taken to determine *both* the correct reamer and pilot sizes. Whether you will use a reamer or pilot is determined in step #5.

3. [ ] Look up appropriate reamer/pilot size in REAMER & PILOT SIZES table (4-2) and record correct sizes here:
_____mm reamer.
_____mm pilot.

In the next step calculate whether reaming is necessary. If the reamer will remove material, then the sum of the calculation will be a negative number (if that number is between .00 and –.05mm then the amount of material removed is insignificant). If the number is equal to or greater than .00mm, then no material will be removed by the reamer. If the number is –.05 or less, then a significant amount of material will be removed by the reamer.

4. Calculate material reamer will remove:

Head tube ID #1	**_____mm**
Head tube ID #2	**+_____mm**
Total of ID#1 + ID#2	**=_____mm**
Divide total by 2	**÷2**
Average ID	**=_____mm**
Subtract reamer size	**–_____mm**
Material removed by reamer	**=_____mm**

5. *Check one of following choices* with regard to reaming:
[ ] Step 4 final sum is > –.05mm, *reaming is not required.*
[ ] Step 4 final sum is £ –.05mm, *reaming is required.*

In the next step you make sure that the reamer/pilot on the tool is the correct size and replace it if necessary. Reamer/pilot dimensions cannot be seen when the reamer or pilot is installed on the handle. *Reamers cannot be measured to determine their dimension.* Most bike shop have one set of reamers/pilots. Often, the easiest way to determine which reamer/pilot *is* on the handle, is to look at the markings on the reamers and pilots *that are not on the handle.* Use a process of elimination to determine which size must be on the handle.

6. [ ] Check or install correct reamer/pilot on reaming/facing tool.

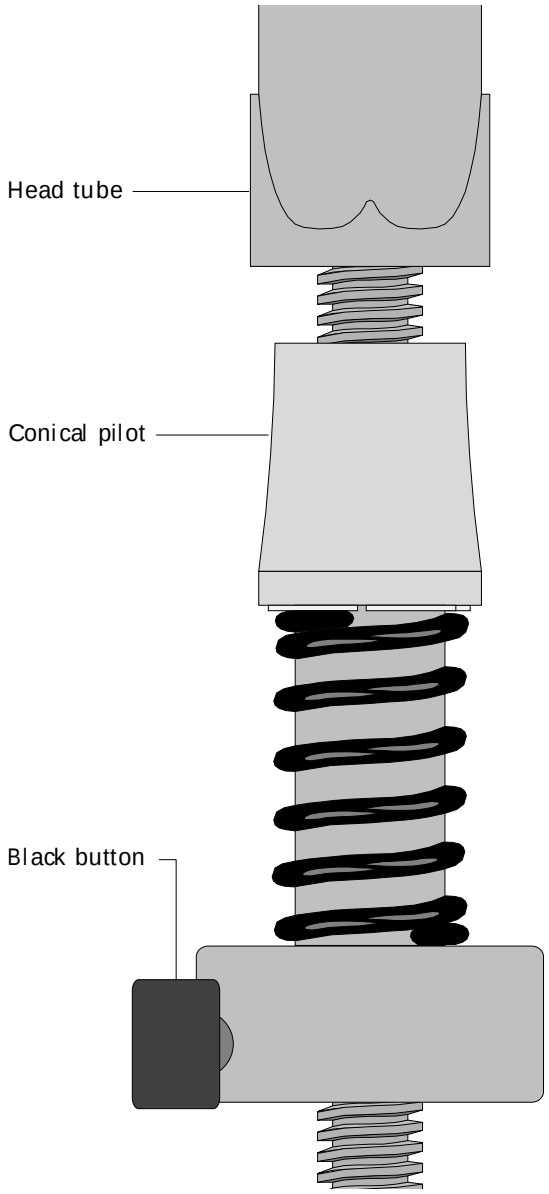
7. [ ] Install reamer/facer into top end of head tube.

In step #8, the tension device is assembled to the tool shaft. Assembly is done differently on different brands of tools.

Park HTR-1:

Depress the large black button on the base of the one-piece tension device.

Slide the device all the way up the shaft and release the button.



4.4 *Tension device for the Park HTR-1.*

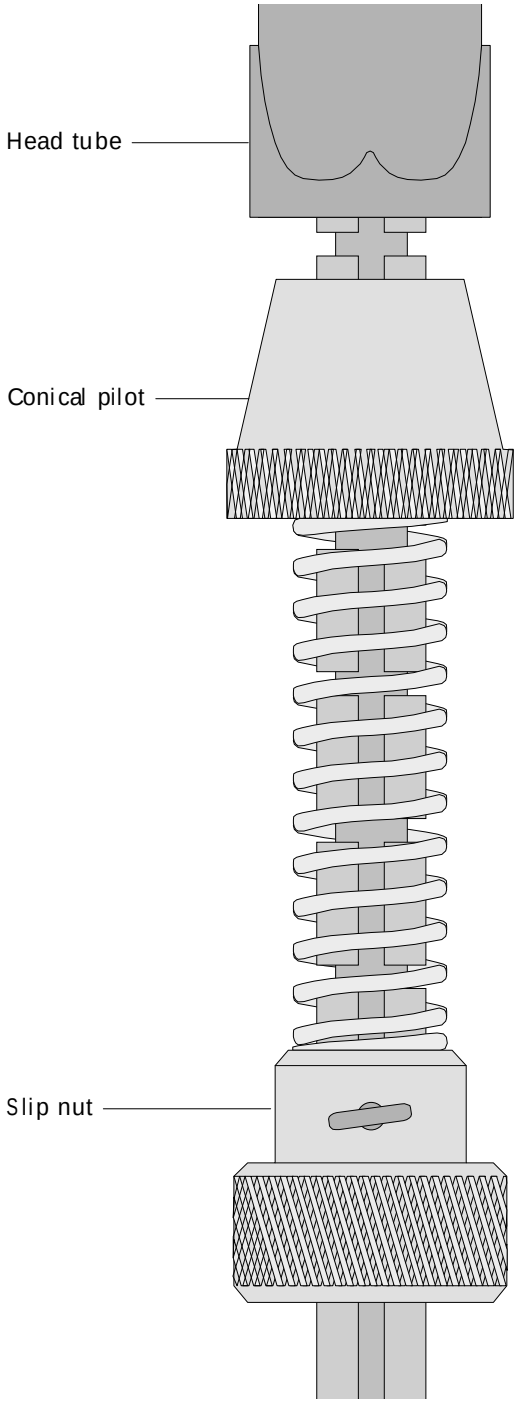
VAR 32C:

Slide the conical pilot up the shaft into the head tube.

Slide the spring onto the shaft.

Rotate the slip nut so that the internal prong lines up with the vertical slot in the shaft and slide the slip nut onto the shaft.

Rotate the slip nut so that the internal prong engages a horizontal slot in the shaft.



4.5 *Tension device for the VAR 32C.*

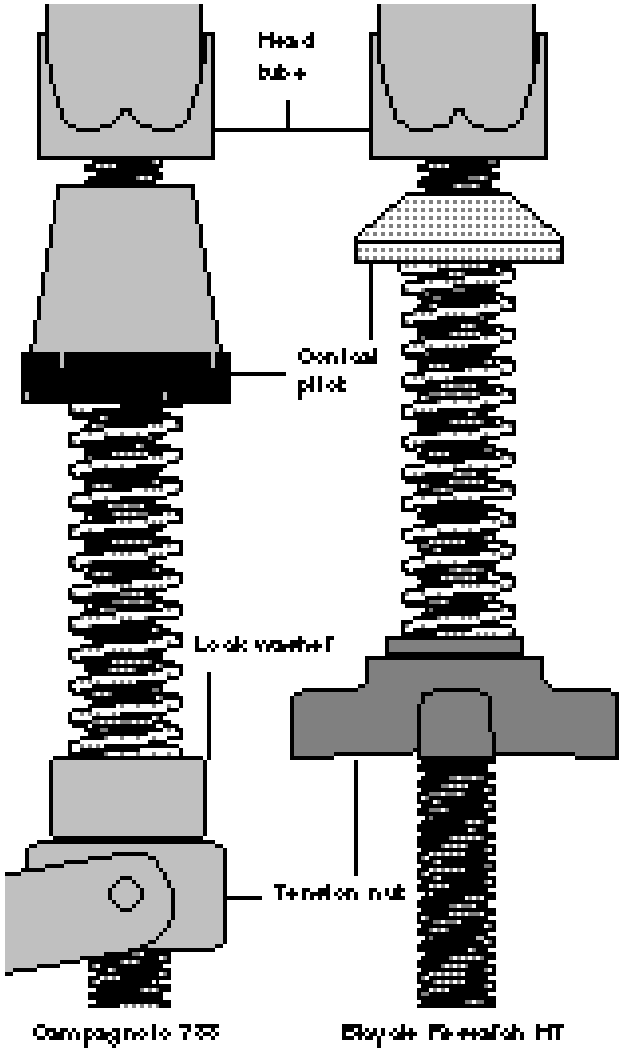
Campagnolo 733 & Bicycle Research HT:

Slide the conical pilot up the shaft into the head tube.

Slide the spring onto the shaft.

Campagnolo only: slip the lockwasher onto the shaft.

Both: thread the tension nut onto the shaft.



4.6 Tension device(s) for Campagnolo 733 and Bicycle Research HT models.

8. [ ] Assemble conical pilot and tension device to end of reamer/facer tool.

When adjusting spring tension on a reamer/facer tool, it is important to not have too much or too little tension. If there is not enough tension, the conical pilot will be loose and jiggling in the head tube and a sloppy cutting job will be done. If there is excessive tension, then too much cutting will happen at once, resulting in greater heat, a rougher cut, and more wear and tear on the cutters.

9. [ ] Adjust spring tension to be just tight enough to keep conical pilot from moving when jiggled.

NOTE: If using a pilot and not a reamer, skip to step 13.

In step #10 generous amounts of cutting oil should be applied to the reamer. This is most easily done by rotating the frame so that the head tube is parallel to the floor. The addition of cutting oil improves the ease and quality of the cut and preserves the sharpness of the tool.

10. [ ] Apply generous amounts of cutting oil to reamer.

Whenever turning a reamer/facer, remember to always turn the tool clockwise, otherwise the tool will dull quickly.

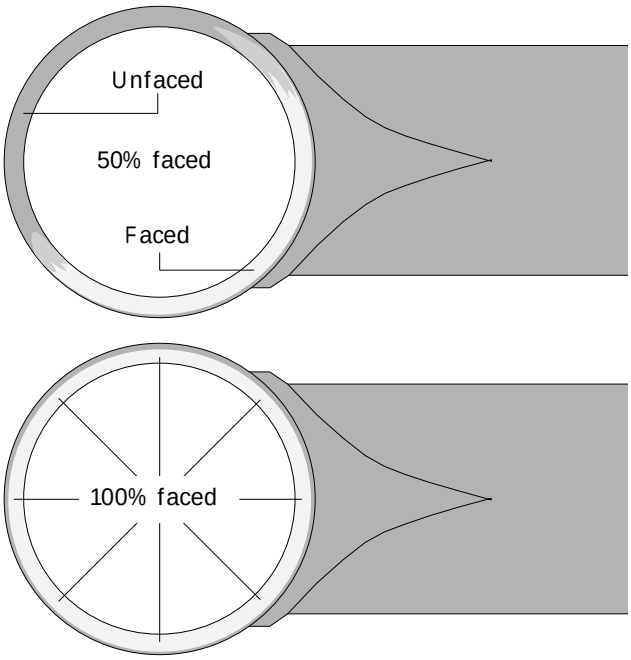
11. [ ] Turn reamer/facer handle *clockwise* several turns, then check whether conical pilot is still secure (if not, tighten tension device).

12. [ ] Add more cutting oil to reamer and repeat steps 10–12 until facer is in contact with end of head tube.

13. [ ] Apply generous amounts of appropriate type of cutting oil to facer.

14. [ ] Turn reamer/facer *clockwise* several turns.

In the next step, inspect the facing progress. A partially faced head tube will have freshly cut metal only for a portion of the 360° face. It is of no concern whether the width of the cut is uniform, only whether there is freshly cut metal for a full 360°. If it is not a full circle, continue on to step #16.



4.7 The cut needs to be a full 360° to be complete.

15. [ ] Loosen tension device, then pull facer away from head tube and check progress of cut.

16. [ ] If more facing is needed, repeat steps 13–16.

Under the pressure needed to cut metal, the facer can leave burrs when it stops. The next step is to spin the facer one more revolution under very light pressure to knock off any burrs. The brand of tool being used determines the appropriate technique for burr removal.