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Rotational Systems — Headset Overhaul & Adjustment

Part One - Preparation

I. Objectives

- A. Reinforce basic concepts of correct tool use.
- B. Review rotational systems and bearing adjustments. Students should be able to describe what a good bearing adjustment is and why, and relate headset parts to the equivalent bottom bracket and hub parts.
- C. Reinforce the math concepts of parallel and perpendicular lines.
- D. Reinforce physics concepts of friction as a type of force.

II. Materials Needed

Demonstration Parts

Fork mounted in a head tube cut out of a bike frame
 Fork, out of bike, with stem mounted in it
 Loose fork w/locknut and adjustable cup
 Pitted races, cups
 Loose stem

Tools

Hook spanner/Lockring wrench
 Headset wrenches
 Slide hammer
 12" Adjustable Wrench
 Crown race remover
 Headset Press
 Allen wrenches
 Combination wrenches
 12" Channel-lock pliers

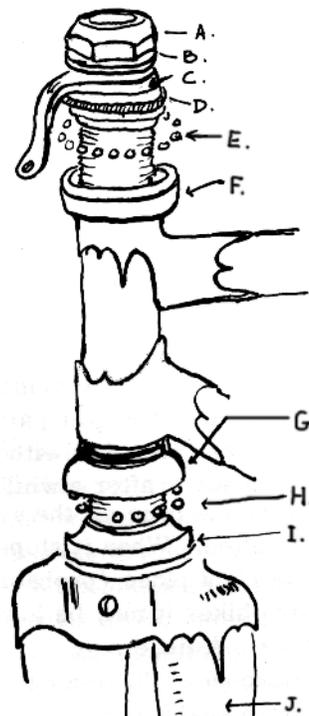
Other Materials

Grease
 Penetrating Oil
 Rags
 Rubber Gloves
 Ball Bearings

III. Setting: Workshop, with tool benches, bike repair stand and bike storage.

IV. Evaluation

- A. Teacher Observation During Work Session
- B. Oral Review at end of work session.
 - 1) **Language:** How many of the parts and specialty tools can students identify? Passively? Actively?
 - 2) **Systems:** Can the student say what components are part of the system on which we've been working? How do these components function together as a whole?
 - 3) **Process:** How many of the steps of the process can students name? Can they get the steps in the correct order?
- C. Written Evaluation How well can student narrate what she did that day on her time sheet?
- D. Test — Make copies of the diagram at right and have students fill in the names of the parts.



A. Locknut B. LockWasher C. Cable Hanger D. Adjusting Cone
 E. Bearings F. Top Frame Race (or cup) G. Bottom Frame Race (or cup)
 H. Bearings I. Fork Race J. Fork Blade



Part Two - Activity Instructions

I. Tool Check! Students & instructors enter the tool area and confirm as a group that all the tools are there.

II. Process

- A. Goal** — The main purposes of each of the bike's rotational systems are: 1) to allow rotation (turning) without a lot of friction and with no side-to-side play; and, 2) to bear weight. A well done headset job also makes sure that:
- your bike has nothing in the headset system that is about to get destroyed or come out (stem not in far enough, head tube not getting “ovalized,” etc.)
 - the headset isn't going to go out of adjustment again soon (due to cup/cone not being locked in place, or due to pressed in cups being loose in head tube)
 - your front brakes work without the sudden jerking that comes from a loose headset

B. Steps to Overhaul a Headset — Go over the name of each step, as a list. Then describe each step to the students and have them each carry out that step on their bike before you move the group onto the next step.

1. Evaluate Condition of existing parts before disassembling. Check the adjustment. Does everything fit together well? Do the bottom edges of the crown race and the pressed in races all appear perpendicular to the head tube? Is the fork visibly bent? Make an initial decision about what to replace.

2. Disassemble

a) Remove the Handlebar-Stem assembly

- Unscrew the stem binder bolt until it lifts away from the top of the stem $\approx 1/4$ "
- Tap the top of the stem binder bolt with a hammer to drive the wedge down out of the top of the fork column.
- Pull up on handlebars and stem, removing the stem from the fork column. Detach front brake cable if necessary. Hang handlebars on bike.

b) Remove the front wheel (why wait until now to remove wheel??)

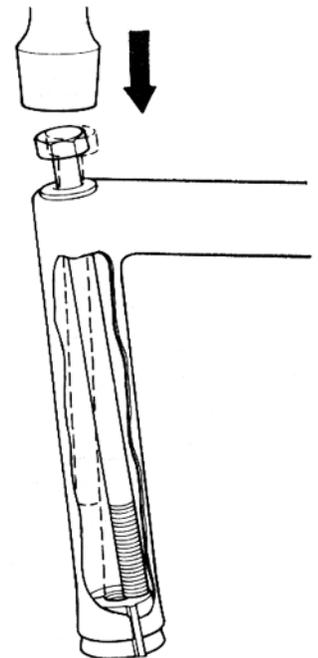
c) Unlock the headset locknut from the race directly under it, unscrew the locknut and the adjustable race all the way, holding up the fork with your other hand so it won't drop out of the bike!

d) Stack up all parts in the order in which you take them off.

e) Pull out the fork from the bottom of the head tube, catching any falling bearings with your hand.

f) Remove any bearings that got left behind in the races that are pressed into the head tube (the “pressed in races”).

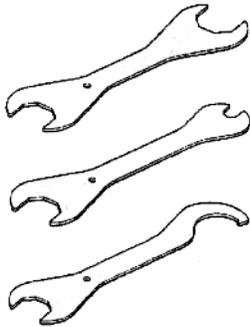
3. Clean and inspect all the bearing surfaces and threads, looking for pits or scratches on the races, bearings or cups. Remove the pressed in races if they are loose or if they need to be replaced. Put the fork in the fork jig to see if it's bent.



**B. Steps to Overhaul a Headset** - continued

4. Replace Parts as necessary and possible! It is hard to mix and match parts from different headsets. What are some of the dimensions (sizes/diameters) that have to be exactly the same? If you don't have a replacement for a pitted race or cup, go ahead and reassemble with lots of new clean grease and new ball bearings. You'll get a better bearing adjustment than you started out with, though not perfect.

5. Reassemble — this is just disassembly in reverse.

**Headset Wrenches**

- a) **Reinstall pressed in races** if you removed them, using press or a hammer on the flat handle of a headset wrench placed across the race. If they were loose, shim them with pieces of an aluminum can.
- b) **Grease the cups** putting a good thick layer in the back of each.
- c) **Install Bearings** If the bearings are in a retainer, check which side faces the cone! If you are using loose ball bearings, fill up the race with a complete ring and then remove two balls.
- d) **Replace crown race** on the fork, if you removed it. If it was loose, shim it with pieces of an aluminum can. Use the slide hammer to get it on tight, all the way down, and parallel to the fork crown.
- e) **Reinstall the fork**, screwing on the adjustable race, washer, any spacers, and the first locknut/locking finger tight.
- f) Ready to adjust!

6. Adjust the bearings — the same basic “not too loose, not too tight” idea as other bearing systems on bike, but your fork is not spinning at 40-100 rpm like your wheel hubs or you bottom bracket spindle. Therefore slightly tight is not as much of a problem as in wheels or bottom brackets.

- a) **Find Out How Good an Adjustment You Can Get** With fingers or tools, screw the adjustable race up and down on the fork column until you find a spot where the adjustment is both not too loose and not too tight.
- b) **Get the Adjustable Race Locked in the Correct Position** If you were just to tighten down the locknut against the race at the “perfect adjustment spot” you just found, the tightening of the locknut will tighten the adjustment slightly, even if you are careful not to let the adjustable race rotate on the fork threads. (Why? How is this similar to the hub adjustment?)
 - starting at the “best adjustment position” you found for the adjustable race in the previous step, carefully loosen the race 30 to 60° (5-10 minutes, thinking of a clock)
 - hold the adjustable race in place, not letting it or the fork rotate, and tighten down the lock nut against the adjustable race. (To hold the fork still, reinstall the front wheel, and hold it between your legs as you do the adjustment.) Test the adjustment for play and grinding.
 - **If it's too loose**, hold the adjustable race completely still while you unscrew the lock nut. Screw in the race just 5° (1 minute) clockwise. Hold it (and fork!) completely still while you tighten the lock nut down against it again. Test adjustment. If it's still too loose, repeat this step. If it's too tight, hold the race still, loosen the lock nut and carefully unscrew the race 1/2 of the distance you just tightened it (about 2 1/2° or 1/2 minute). Tighten down the lock nut while holding the race still and check the adjustment again.



6. Adjust the bearings - continued

- If it's too tight, hold the adjustable race completely still while you unscrew the lock nut. Unscrew the cone just 5° (1 minute) counterclockwise. Hold it completely still while you tighten the lock nut down against it again. Test the adjustment. If it's still too tight, repeat this step. If it's too loose, hold the race still, loosen the lock nut and carefully screw in the race (clockwise) 1/2 of the distance you just loosened it (about 2 1/2° or 1/2 minute). Tighten down the lock nut while holding the race still and check the adjustment again.
- If there is a second locknut, tighten it down against the first locknut/lockring.
- The most important ideas here are:
 - ◊ Don't lose your point of reference by letting the adjustable race or the fork column move as you loosen back up the lock nut, because you'll have to start all over again.
 - ◊ Tiny rotations of the race make a big difference in the pressure on the bearings. How far are you moving the race along the fork column if you turn it, say, 1/4 turn (90° or 15 minutes)? Hint: How many threads per inch (tpi) are there on the fork column?

7. Reinstall the Handlebars and Stem

III. Language Skills

Over the course of the lesson we should introduce all of these terms. At the end of the session it is often helpful to get each student to touch each of these parts on his/her bike & say the name.

Handlebar-Stem System

- Handlebars (HBs)
- Stem
- Stem Binder Bolt
- HB Binder Bolt
- Stem Binder Bolt Wedge
- Grips or HB Tape

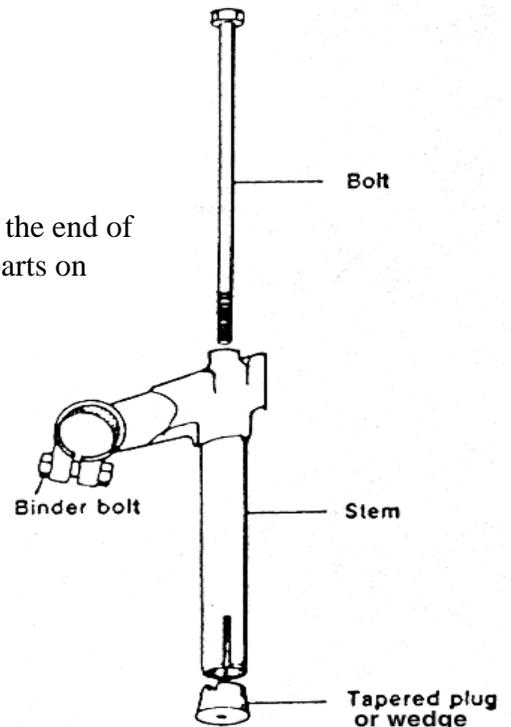
Fork

- Fork Blades or Tines
- Fork Crown
- Drop-outs
- Fork Column
- Head Tube (frame part)

Head Set

- Crown Race
- Adjustable Race/Cup
- Pressed-In Cups (Upper and Lower)
- Washer (with or without key)
- Lockring*
- Locknut
- Bearing Retainers
- Ball Bearings
- Brake Hanger*
- Reflector Bracket*
- Headset Spacer*

* Not included in all headset arrangements



The Headset - Stem Parts

**III. Language Skills** - continued**Specialty Tools**

Headset wrenches
Hook spanner/
Lockring wrench
Headset Press
Slide hammer
Crown race remover

Common Tools

Hammer
Flat End Punch
Allen wrenches
12" Adj. Wrench
Combo. wrenches
12" Channel lock pliers

Math Words

Diameter
Length
tpi-threads per inch
millimeters (mm)
Parallel
Clockwise
Counter Clockwise
Perpendicular - 90°

Materials

Grease
Rags
Penetrating Oil

IV. System Understanding Try different ways of phrasing this question.

“What components are part of the Headset system?” “How do they interact/affect each other/work together?”
“How do the components function as a whole?” “What is the bigger system the Headset is a part of (Steering system)?” “What are the parts of the Steering System?”

V. Problem Solving/Diagnosis

- A. What are three possible causes of play felt when you try to rock the fork column from front to back in the head tube? How could you figure out which is the actual cause?
- B. If you are trying to adjust a headset perfectly, and you get both play (looseness) and some grinding (tightness) at one single position of the adjustable race, what are some possible causes? How could you figure out which is the actual cause?
- C. What other problem solving did we do?

VI. Review**VII. Clean Up**

VIII. Tool Check! Leave tool area as a group after confirming that all tools are present.



Rotational Systems: (Quiz/Review)

1. What are the symptoms that would require replacement of parts in Rotational Systems?

2. Describe how the locking systems work in each of the Rotational Systems studied.

3. How would a bent axle affect a hub's performance?

4. Where do you check for wear in Rotational Systems?

5. What happens when bearing systems are adjusted too tightly? too loosely?
 - 5a. If running out of time or patience (student or teacher), is it better to leave adjustment a little too tight or a little too loose?

6. How can you be sure not to install a bearing retainer backwards?