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Rotational Systems — Bottom Bracket Overhaul & Adjustment

Part One - Preparation

I. Objectives

- A. Reinforce basic concepts of correct tool use.
- B. Introduce rotational systems and bearing adjustments. Students should be able to describe what a good bearing adjustment is and why.
- C. Reinforce the math concepts of parallel and perpendicular lines. Introduce the physics concepts of force and friction.

II. Materials Needed

Demonstration Parts

(All removed from bike)
One piece crank w/chainring, cups, and rest of BB set
BB Spindle & Cottered crank set
BB Spindle & Cotterless crank set
BB cup set w/ bearings in retainer, on a spindle
Pitted cups, spindle, bearings

Tools

Hook spanner/Lockring wrench
Fixed cup remover
Hammer
12" Adj. Wrench
Pedal Wrench
Bottom Bracket/Headset Press
Pin Tool
Flat End Punch

Other Materials

Grease
Penetrating Oil
Rags
Rubber Gloves
Loctite

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

IV. Evaluation

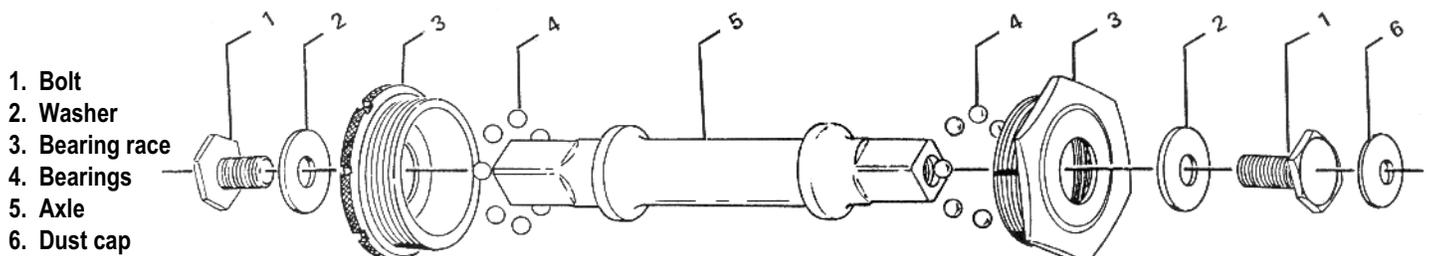
A. Teacher Observation During Work Session

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 they worked? How do the components function 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 below and have students fill in the names of the parts.





Part Two - Activity Instructions

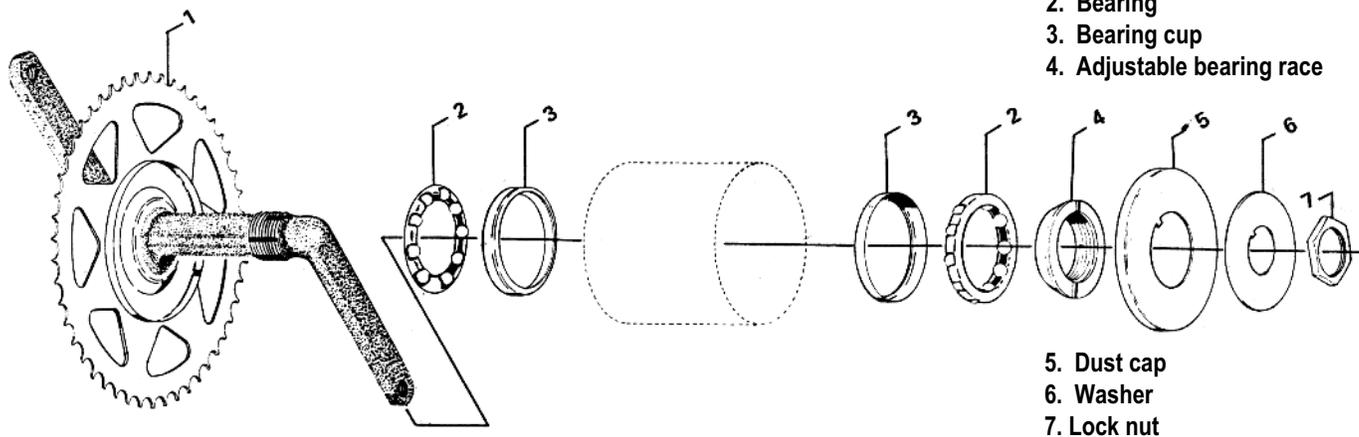
I. Tool Check! Instructors enter tool area with students and confirm as a group that all tools are present.

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 bottom bracket job also makes sure that:
- your bike has nothing in the bottom bracket/crank system that is about to break (crank arm or pedal about to fall off, etc.)
 - the BB set 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 collapsing inwards in a one piece crank set)

B. Steps to Overhaul a One-Piece Bottom Bracket (Ashtabula style) — 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? How is the chain line? Are the chainrings, pedals or the crank arms bent? Make an initial decision about what to replace.



2. Disassemble

- a) Remove the Left Pedal (unscrews clockwise! - it's a "left-hand thread")
- b) Unlock the lock nut from the cone on the Left side (the adjustable side) - this is also a "left-hand thread," unscrew both all the way, taking them off the crank arm, along with whatever washer is on that side.
- c) Stack Up All Parts in the order in which you take them off!
- d) Pull out the Left Bearing Retainer
- e) Pull out the Crank Arm and the right bearing retainer

**B. Steps to Overhaul a One-Piece Bottom Bracket** - continued

3. **Clean and Inspect** all the bearing surfaces and threads, looking for pits or scratches on the cones, bearings or cups. Remove cups if they are loose or look like they may be getting pushed inwards, or if they need to be replaced.
4. **Replace Parts** as necessary (and possible! if you don't have a replacement for a pitted cone or cup, go ahead and reassemble with lots of new clean grease. You'll get a better bearing adjustment than you started out with, though not perfect). If the cups are starting to collapse inwards (compare profile to a new cup), you have to replace them.
5. **Reassemble** — this is just disassembly in reverse.
 - a) Reinstall cups if you removed them, using press or a hammer on the flat handle of a headset wrench placed across cup.
 - b) Grease the cups putting a good thick layer in the back of each.
 - c) Slide Right Bearing Retainer onto Crank Arm, up against Right Cone Check which side of the retainer faces cone!
 - d) Slide crank arm back through BB
 - e) Reinstall Left bearing retainer, adjustable cone, washer and locknut finger tight.
 - f) Reinstall the Left Pedal (screws in counterclockwise). Ready to adjust!
6. **Adjust the bearings.**
 - a) Find Out How Good an Adjustment You Can Get With fingers or tools, screw the adjustable cone in and out on the crank until you find a spot where the bearing adjustment is both not too loose and not too tight (how do you check?)
 - b) Get the Adjustable Cone Locked in the Correct Position
 - starting at the “best adjustment position” you found for the cone in the previous step, carefully loosen the cone (turning it clockwise!) 45° (7 minutes, thinking of a clock)
 - hold the cone in place, not letting it or the crank arm rotate (what tool do you need?), and tighten down the lock nut against the cone. Test the adjustment for play and grinding.
 - If it's too loose, hold the cone completely still while you unscrew the lock nut. Screw in 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 loose, repeat this step. If it's too tight, hold the cone still, loosen the lock nut and carefully unscrew the cone 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 cone still and check the adjustment again.
 - If it's too tight, hold the cone completely still while you unscrew the lock nut. Unscrew the cone just 5° (1 minute) clockwise. 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 cone still, loosen the lock nut and carefully screw in the cone (counterclockwise) 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 cone still and check the adjustment again.

**6. Adjust the bearings.** (continued)

- The most important ideas here are:

- ◊ Don't lose your point of reference by letting the cone move as you loosen back up the lock nut, because you'll have to start all over again.
- ◊ Tiny rotations of the cone make a big difference in the pressure on the bearings. How far are you moving the cone along the axle if you turn it, say, 1/4 turn (90° or 15 minutes)? Hint: How many threads per inch (tpi) are there on the crank?

C. Steps to Overhaul a Three-Piece Bottom Bracket — 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. Does everything fit together well. How is the chain line? How much clearance is there between the chainstays and the crank arms? Are the chainrings, pedals or the crank arms bent? Decide if any of these external parts need to be replaced. Test the adjustment.

2. Disassemble

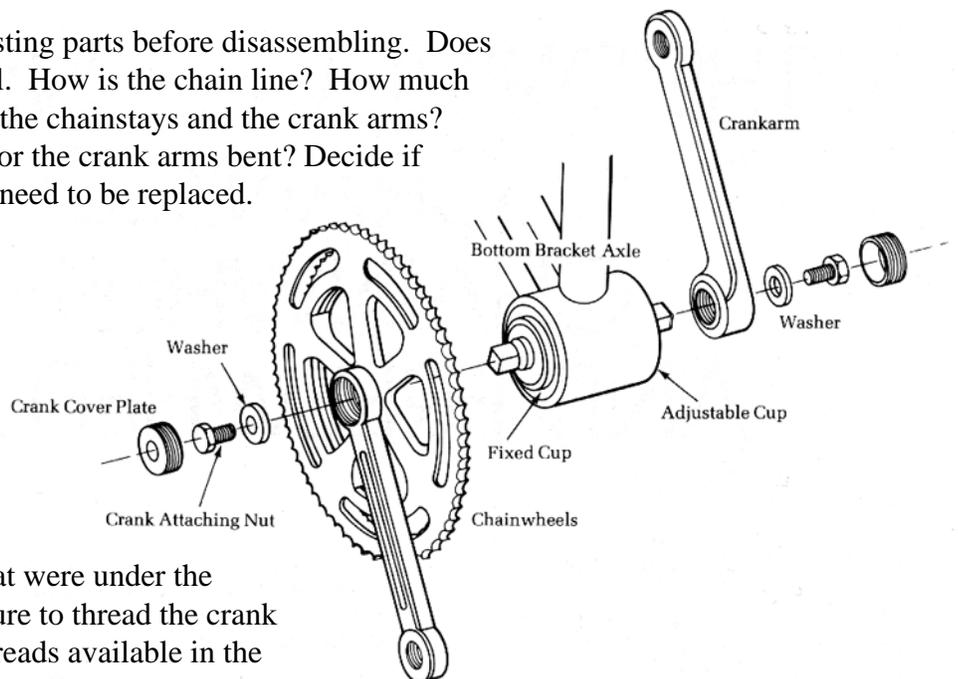
- a) Remove the crank arms

with the cotterless crank puller or the cotter pin press

- Cotterless: start w/left crank, it costs less if you ruin it! Be sure to remove any washers that were under the crank bolt or nut. Be sure to thread the crank puller in until all the threads available in the crank are engaged in the puller.
- Cottered: always squirt penetrating oil down the cotter pin and remove the nut before you attempt to press the pin out.

- b) Test the adjustment again with the crank arms off. Notice how the reduced leverage makes the bearings feel tighter and how it is easier to feel roughness.
- c) Unlock the lock ring from the adjustable cup on the Left side, unscrew the adj. cup, taking it out of the BB shell, along with the bearings inside it (they may be loose or in a retainer).
- d) Pull out the Spindle and the Bearings from the fixed cup. If one end of the spindle is longer than the other, notice which side it was facing.
- e) Stack up All Parts in the order in which you take them off!

- 3. Clean and Inspect** all the bearing surfaces and threads, looking for pits or scratches on the cones, bearings or cups. Inspect the fixed cup with a flashlight and a ball point pen. Remove it only if it will be replaced.



**C. Steps to Overhaul a Three-Piece Bottom Bracket (continued)**

4. Replace Parts as necessary (and possible! if you don't have a replacement for a pitted spindle or cup, go ahead and reassemble with lots of new clean grease — you'll get a better bearing adjustment than you started out with, though not perfect).

5. Reassemble this is just disassembly in reverse.

a) Make sure the Fixed Cup is Tight, using the fixed cup remover if necessary.

b) Grease the cups putting a good thick layer inside each.

c) Stick the Bearings back in the Cups

- For bearings in retainers, check which side faces cup!
- If bearings are loose, there should be 11 of them (1/4" balls)

C. Steps to Overhaul a Three-Piece Bottom Bracket - continued

d) Stick in the Spindle, making sure that if one end is longer, it faces in the right direction.

e) Reinstall Adjustable Cup, and Lockring. Ready to adjust!

6. Adjust the bearings.

a) Find Out How Good an Adjustment You Can Get

- Reinstall the right crank so that you can use it as a lever when you check the adjustment. Secure it well.
- With fingers or tools, move cup in and out until you find a spot where the adjustment is both not too loose and not too tight (how do you check?)

b) Get the Adjustable Cup Locked in the Correct Position

- This process is the same as for a one piece crank, with one exception: the action of tightening the lockring against the frame forces the cup out rather than further in. Therefore the bearing adjustment gets looser as you lock down the lockring.
 - So, starting at the "best adjustment position" you found in the previous step, carefully tighten the cup (turning it clockwise) 20° (about 3 minutes, thinking of a clock). Then hold the cup still while tightening down the lockring.
- Check the adjustment... if too loose or too tight, proceed as with the one-piece crank.



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.

Crank Set

Crank Arm, L & R
Chainrings & Spider
Crank Nuts/Bolts
Cotter Pins
Cottered/Cotterless
Pedals
Bottom Bracket Shell (frame part)

Bottom Bracket Set

(Three Piece Crank Set)
Fixed Cup
Adjustable Cup
Lockring
Spindle
Ball Bearings
Dust Seal

Bottom Bracket Set

(One Piece Crank Set)
Fixed & Adj. Cones
Lockwasher
Locknut
Spacer
Ball Bearings
Bearing Retainers
Cups (pressed in)

Specialty Tools

Fixed Cup Remover
Pin Tool
Lockring wrench
BB/Headset Cup Press
Pedal Wrench

Other Materials

Grease
Rags
Penetrating Oil

Common Tools

Hammer
Flat End Punch
12" Adj. Wrench

Math Words

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

Note: The Bottom Bracket Set and the Crank Set are both part of the larger system called the Drive Train. Another part of the drive chain that you'll probably deal with in this lesson is the chain.
Other words: Left-Hand Threads, Right-Hand Threads.

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

What components are part of the Bottom Bracket system? How do they interact/affect each other/work together? How do they function as a whole?

What is the bigger system the Bottom Bracket is a part of (the Drive Train)?

V. Problem Solving/Diagnosis

- A. On a three piece crank, what are three possible causes of play felt when you try to rock the crank arm from side to side? How could you figure out which is the actual cause?
- B. If you adjust a one-piece crank perfectly, making sure to secure the lock nut well on the adjustable side, and then the adjustment is loose again after only a little riding, 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.



Alternate Text for Three-Piece Crank Adjustment

(Each step intended where it says, “ proceed as with the one-piece crank” is detailed here.)

6. Adjust the bearings.

a) Find Out How Good an Adjustment You Can Get

- Reinstall the right crank so that you can use it as a lever when you check the adjustment. Secure it well.
- With fingers or tools, move cup in and out until you find a spot where the adjustment is both not too loose and not too tight (how do you check?)

b) Get the Adjustable Cup Locked in the Correct Position

- starting at the “best adjustment position” you found for the cup in the previous step, carefully tighten the cup (turning it clockwise) 20° (about 3 minutes, thinking of a clock)
- hold the cup in place, not letting it rotate, and tighten down the lockring against the frame
- Test the adjustment for play and grinding
- If it's too loose, hold the cup completely still while you unscrew the lockring. Screw in the cup just 5° (1 minute) clockwise. Hold the cup completely still while you tighten the lockring back down against the frame. Test the adjustment. If it's still too loose, repeat this step. If it's too tight, hold the cup still, loosen the lockring and carefully unscrew the cup 1/2 of the distance you just tightened it (about 2 1/2° or 1/2 minute). Tighten down the lockring while holding the cup still and check the adjustment again.
- If it's too tight, hold the cup completely still while you unscrew the lockring. Unscrew in the cup 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 cone still, loosen the lock nut and carefully screw in the cup (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 cone still and check the adjustment again.
- The most important ideas here are:
 - ◊ Don't lose your point of reference by letting the cone move as you loosen back up the lock nut, because you'll have to start all over again.
 - ◊ Tiny rotations of the cone make a big difference in the pressure on the bearings. How far are you moving the cone up along the axle if you turn it, say, 1/4 turn (90° or 15 minutes)? Hint: How many threads per inch (tpi) are there on the crank.
