Contents

Rotational Systems — Hub Overhaul and Adjustment

Part One - Preparation

I. Objectives

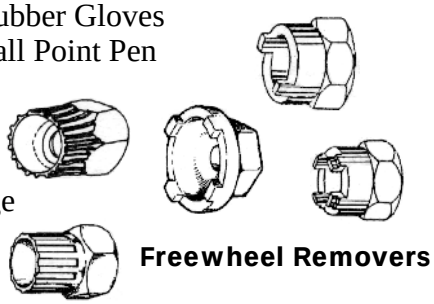
A. Student can identify a hub in need of adjustment.
B. Student can name the parts of the hub system and the tools used on it.
C. Student becomes more familiar with the math concepts of perpendicular and parallel.
D. Student becomes more familiar with the physics concepts of friction and force.
E. Student can describe all the major steps of hub overhaul, and follow all the steps.

I. Materials Needed

Demonstration Parts
Hub, assembled w/guts but no dust caps
Axle w/cone and lock nut on either end, one side locked
Empty hub
Front & rear hubs w/o wheel
Pitted hub, cone, bearings

Tools
15 &17 mm Combo Wrench (optional)
Adjustable Wrenches
Cone Wrenches
Flat ended screwdriver
Freewheel/cassette Remover
Bench Vise
Chain Whip

Other Materials
Grease
Penetrating Oil
Rags
Rubber Gloves
Ball Point Pen


Freewheel Removers

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

IV. Evaluation

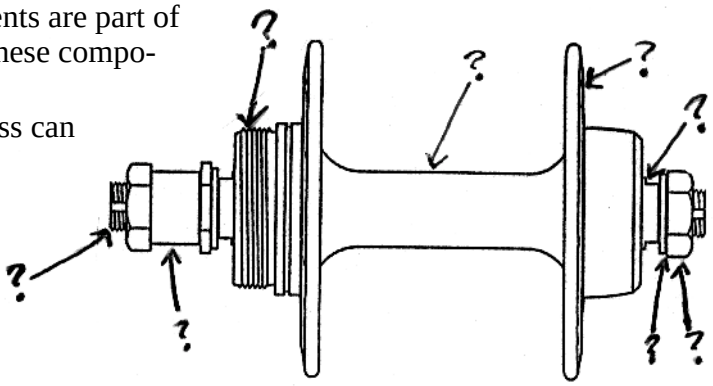
A. Teacher Observation During Work Session Rotate amongst the students you are working with. Observe for general mechanics skills (e.g. body mechanics, tool use), work habits (e.g. keeping part orderly, replacing tools), and ability to follow the steps of the process in the proper order. Observe for problem solving skills: Is student using visual observations? Is student able to pose questions whose answers will help her come up with a solution?

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 these 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 Can student identify the parts in this diagram? Is this a front hub or a rear hub?



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 — What are we trying to get done when we adjust or overhaul a hub? Have you ever ridden a bike where the wheel was knocking from side to side? What can happen? How does that side-to-side play affect your brakes? How hard it is to pedal? The main purposes of each of the bike's rotational systems are: 1) to allow rotation (turning) without a lot of friction, and, 2) to bear weight. A well done hub adjustment or overhaul makes sure that:

- the hub is adjusted so that there is no play (when the wheel is firmly attached to the bike), **and** hardly any friction (not too loose, not too tight). In order to get no play, the axle must be perpendicular to the plane of the cups. Why?
- the hub isn't going to go out of adjustment again soon (due to cone not being locked in place, or the parts being pitted or cracked already)
- the bearings are well lubricated, both to reduce friction and to prevent rust (why don't we want rust?)

B. Steps to Overhauling and Adjusting a Hub — Go over the names of each step, as a list. Then describe each step to the students and have them each carry out that step on their bikes before you move the group onto the next step.

1. Evaluate Condition of as many parts as possible without disassembling.

a) Check Adjustment first on bike, by moving wheel; then off the bike, by moving axle. Is there both grinding and play? Any idea what this might mean about the parts inside? (Come back to this idea when doing the adjustments.)

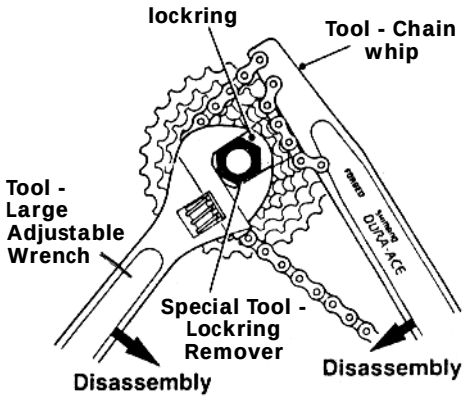
b) Axle Straight? rotate it while it's still in the hub, does the end seem to wobble around, or does it stay in one place?

c) Axle Threads OK? are they mushed, or flattened?

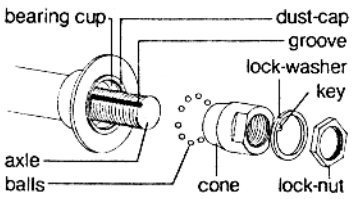
d) Dust Caps flat, fitting well into hub?

2. For Rear Wheels, **Remove the FreeWheel** and remove the Cassette if it's the type where you can't get to the slots in the cone with the cassette on.

3. Decide if Hub Needs to be Overhauled If you can get a good adjustment (no play and no grinding), then the bearings and the bearing surfaces on the cones and in the cups inside are all in good shape and well lubricated. If your goal is just to get the bike ready, skip to step 8 and try an adjustment. If you want to teach the overhaul anyway, go on to step 4.



Removing a Cassette.



Hub-bearing detail

4. Disassemble

a) Unlock the lock nut from the cone on one end of the axle, unscrew them all the way, taking them off the axle.

b) Stack Up All Parts in the order in which you take them off!

c) Pull out the Axle , then remove the dust caps gently with a flat end screw-driver

(don't take them out of cassette hubs or 1963 Normandy Competition hubs).

d) Pull out the Bearings

5. Clean and Inspect all the bearing surfaces and threads — rub them with a rag.

a) Pits or scratches on the cones, bearings or cups?

b) Axle Straight ? roll it on flat table

c) Threads mushed?

6. Replace Parts as necessary (and possible! if you don't have a replacement for a pitted cone, 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).

7. Reassemble this is just disassembly in reverse.

a) Grease the cups putting a good thick layer in the back of each.

b) Stick in the ball bearings

- Rear Hubs: nine 1/4" balls on each side
- Front Hubs: ten 3/16" balls on each side


Bearings come in many Different Sizes

c) Install Dust caps if you took them out, tap them with a hammer against the flat of a cone wrench

d) Stick the Axle through the Hub Which end goes on which side? Screw the cone, any spacer, washer and lock nut back on the other end. You are ready to adjust!

8. Adjust the bearings.

a) Make the **Right** End of the Axle the Fixed Side (R. cone is dragged on by bearings in a direction that makes it want to screw down in tighter on the bearings.) Start w/wheel vertical on bench or floor.

- Cone Wrench in left hand, in slots on cone, horizontal
- Fixed or Adjustable Wrench in Right Hand on lock nut, horizontal, opposite the cone wrench
- Tighten Them Against Each Other —lean down on the wrenches. You'll be turning the cone counterclockwise, unscrewing it, and at the same time, turning the lock nut clockwise, tightening it against the cone.

cone wrench

b) Hold the Axle still, using the Fixed Side as a handle.

- put the lock nut of the fixed side in the bench vise, or get a friend to hold a wrench on the lock nut, bracing her hand against the spokes.

c) Find the Right Position for the Cone on the Adjustable Side, and Lock it in Place.

- with two fingers lightly rotating the cone wrench clockwise, turn it until you feel it just hit the bearings, then back the cone off 90° (15 min. on clock)
- test for play by seeing if wheel rocks against axle. Move the cone another 5 or 6° (1 minute) clockwise, test for play again. Repeat this move until you find a spot where the play almost (but not quite) disappears.

c) Find the Right Position - continued
- Finish the Adjustment by tightening down the Lock Nut against the Cone while holding the cone completely still (with the cone wrench!).
- Test the adjustment for play and grinding. (If it's a quick release (QR) hub you have to take it out of the vise, install the QR skewer, and clamp it down against either the frame or a set of drop-outs cut out of an old frame.)
- If it's too loose, hold the cone completely still while you unscrew the lock nut. Screw in the cone just 5° (1 minute) clockwise. Hold the cone 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 now 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) counterclockwise. Hold the cone 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 now it's too loose, hold the cone still, loosen the lock nut and carefully screw in the cone (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.

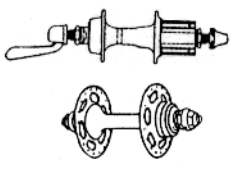
- The most important ideas here are:
  - ◊ Don't lose your point of reference by letting the cone move as you loosen back up the lock nut, so you don't have to start all over again.
  - ◊ Tiny rotations of the cone make a big difference in the pressure on the bearings. How far are you moving the cone along the axle if you turn it, say, 1/4 turn (90° or 15 minutes)? Hint: there are probably 26 threads per inch (tpi) on the axle.

d) Reinstall the FreeWheel or Cassette, if you took one off.

9. Remount Wheel in Frame

a) Make sure it's centered (look at frame, not brake pads!)

b) Make sure it's tightened (What could happen if your wheel falls off?)

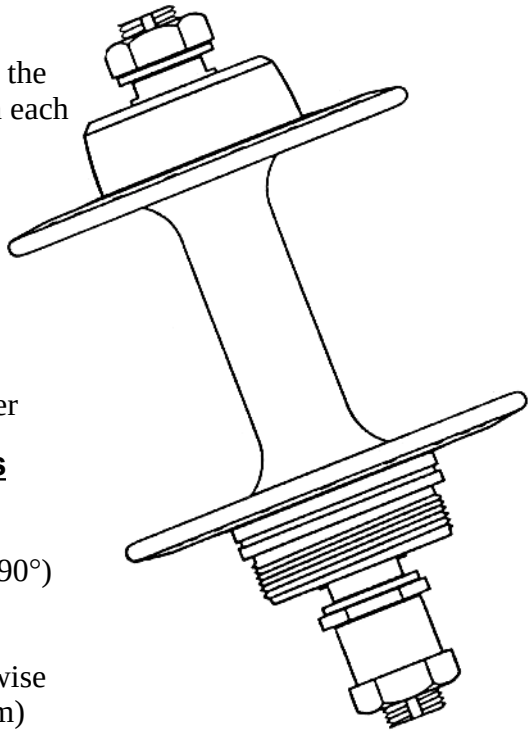


Remember: Quick Release hubs - small amount of play before the wheel is locked in frame

Bolt-On hubs — no play

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 kid to put their finger on each of these parts on his/her bike & say the name.



Hub
Hub Flange
Hub Cups
Bearing Race
Dust Cap

Axle Set
Axle: solid/hollow
Cone
Bearing Race
Lock Washer
Lock nut
Axle Spacer

Other
Axle Nut
Axle Washer
Quick Release (QR) skewer
Ball Bearings
Bearing Retainer

Necessary Tools
15 &17 mm Combo Wrench (optional)
Adjustable Wrenches
Cone Wrenches
Flat end Screwdriver
Bench Vise
Chain Whip
Freewheel/cassette Remover

Other Materials
Grease
Penetrating Oil
Rags
Rubber Gloves
Ball Point Pen

Math Words
Diameter
Length
Perpendicular (90°)
Parallel
Clockwise
Counter Clockwise
millimeters (mm)
tpi- Threads Per Inch

Note: The Hub and Axle Set are both part of the larger system called the Wheel or Pneumatic Suspension System. In this lesson you will also remove wheels, dealing with these parts from other systems on the bike: Drop outs, Rear Derailleur, chain, Fork.

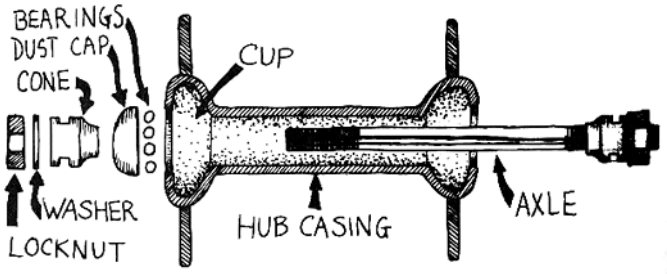
IV. System Understanding

Try different ways of phrasing this question.

"What components are part of the rotational system in the hub?" "How do they interact/affect each other/work together? How do they function as a whole? What is the bigger system the Hub is a part of?

V. Problem Solving/Diagnosis

1. What does it mean if you get an adjustment that has both play and rough spots or grinding? What are the possible causes?
2. How can you tell if you need an overhaul?
3. If your hub became loose soon after you adjusted, what do you think the reason would be? How could you test your theory (guess)?
4. 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.