13 – CARTRIDGE-BEARING HUBS

ABOUT THIS CHAPTER

This chapter is about cartridge-bearing hubs. These hubs are often called sealed-bearing hubs, but both adjustable-cone hubs and cartridge-bearing hubs can have sealed bearings. The design of cartridge-bearing hubs varies tremendously, with almost every manufacturer designing hubs in a different way. About the only factor all cartridge-bearing hub manufacturers have in common is that they all use a cartridge bearing that is pressed into the hub shell. Hadley and Conrad are names that are sometimes used for the cartridge bearing. Cartridge-bearing hubs include front hubs, rear hubs that accept a thread-on freewheel, and freehubs (rear hubs that have the freewheel mechanism integrated into the hub).

There is no way all brands and models can be covered in this chapter, so several common or representative types have been selected. The first hub covered here is a SunTour type with a threaded axle, much like an adjustable-cone hub. This type of cartridge-bearing hub is sold under the SunTour name and under the names Matrix, Sanshin, Specialized, and Performance. Cane Creek hubs are similar to the SunTour type. The second type of cartridge-bearing hub has an unthreaded axle. Nuke Proof is an example of this type of hub. It is similar (but not identical) to hubs made by American Classic, Bullseye, and Cook Bros. The third type is the Hügi hub, which is a unique design, but common enough to merit covering it. The fourth hub is a Ringlè hub, which is also unique. The fifth type is a Phil Wood FSA model. The next hub is a White Industries TI Cassette Hub, and finally the Chris King hub. There is also a section on special tools required for these hubs.

GENERAL INFORMATION

TERMINOLOGY

Hub shell: The main structure of the hub. The hub shell includes the housing for the bearings, which contains a hub core and two hub flanges.

Axle: The shaft that goes through the hub, about which the hub turns.

Bearing cartridge: A fully self-contained bearing unit that cannot be disassembled. A bearing cartridge includes ball bearings and an inner and outer race. The bearings are usually hidden behind seals. The entire assembly is shaped like a short cylinder with a hole through the center.

Inner race: The cylinder at the inner perimeter of a bearing cartridge.

Outer race: The cylinder at the outer perimeter of a bearing cartridge.

Locknut: A nut that threads onto an axle and against another locknut or the bearing cartridge to lock the position of the bearing cartridge relative to the axle.

Sleeve nut: A locknut that threads onto an axle and inserts into the bearing cartridge to lock the position of the bearing cartridge relative to the axle.

Dustcap: A piece that threads or presses onto the outer end of the hub shell to cover the hole through which the bearings are accessed.

Circlip: A metal ring that fits in a groove on the outside or inside or a cylinder to trap the location of another item, on or in, the cylinder. Its shape must be deflected to get a circlip out of its mounting groove. Sometimes called a *snap-ring*.

PREREQUISITES

Wheel removal and installation

Before overhauling or adjusting a hub, the wheel must be removed from the bike. See the **WHEEL REMOVAL, REPLACEMENT, AND INSTALLATION** chapter (page 18-6) if unsure about wheel removal and installation.

Freewheel removal and installation

To overhaul or adjust a rear hub with a thread-on freewheel, it is necessary to remove the freewheel. See the **FREEHUB MECHANISMS AND THREAD-ON FREEWHEELS** chapter (page 25-9) for freewheel removal. If not yet be acquainted with chapter 25, it may be unclear whether the hub has a thread-on freewheel or is a freehub. If the hub is a SunTour brand freehub, the hub core will appear unusually fat. If unsure, or if a mistake identifying whether the hub is a freehub is made, it will not be a big problem. If unsure or mistaken in identifying

whether the rear hub is a freehub, it will not be a big problem. If the rear hub is actually a freehub, then when attempting freewheel removal no notches or splined hole in the face of the freewheel will be found to engage the freewheel remover. This chapter is also needed to perform an optional freehub-body removal and installation on a freehub.

INDICATIONS

There are several reasons to overhaul the hub(s), and several reasons to adjust them. An overhaul should be done as part of a regular maintenance cycle, the duration of which will change depending on the type of riding, the amount of riding, and the type of equipment. Adjustments should be done on the basis of need.

Maintenance cycles

If starting out with hub(s) known to be in good condition with good quality grease, they should be able to be ridden thousands of miles without needing an overhaul. If the equipment sees little wet-weather riding, then an appropriate maintenance cycle would be 2000–3000 miles in most cases. This short cycle may be surprising. It is commonly thought that cartridge-bearing hubs are maintenance-free because they are "sealed." The seals in these hubs are effective for keeping dirt out, and increase the longevity of the grease by minimizing exposure to air that dries out grease. The seals are no guarantee that water will not get in the bearings, and they do not prevent internal wear from contaminating the grease with microscopic abrasive particles of metal. If a lot of wet-condition riding is done, then the maintenance cycle might need to be as often as every 750–1000 miles. Parts rust whether being ridden or not, so another factor is how long the bike may be sitting before it will be used again. For example, if ridden 200 miles in the rain in the fall, then put away four months for the winter, it would probably be a good idea to overhaul the hub(s) before putting the bike away for the winter.

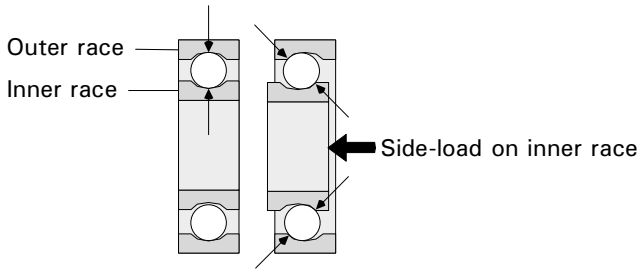
Another factor affecting the maintenance cycle is whether there is grease injection. *Grease-injection systems do not eliminate the need for overhaul.* They only increase the acceptable time between overhauls; furthermore, they are only as good as the customer is consistent and thorough about pumping in new grease. At best, they can lengthen the acceptable time between overhauls. With grease-injection systems, the best policy is to initially overhaul the hub(s) on a normal length maintenance cycle, and if the grease is found to be in good condition, then extend the cycle the next time.

Symptoms indicating need of overhaul

What symptom would lead to the feeling that the hub(s) should be overhauled? One is that when turning the axle it does not turn smoothly. Since there are no adjustments on most cartridge-bearing hubs, the tightness is unlikely to be caused by a poor adjustment. The lack of smoothness could be caused by dry grease, contaminated grease, or worn parts. Another is that when removing the wheel and rotating the axle, the end of the axle oscillates, indicating a bent axle (which should always be replaced). Yet another symptom is a squealing or clicking sound coming from the hub that indicates a bearing is loose in its mount. Finally, the hub may have a broken axle, which may not be obvious until the quick-release skewer is removed, and then the axle falls out in two pieces.

Symptoms indicating need of adjustment

Technically, cartridge bearings cannot be "adjusted." This is because, unlike an adjustable-cone hub which has a cup facing out toward the end of the axle and a cone facing in toward the middle of the axle, a cartridge bearing has an inner race facing out from the *axis* of the axle and an outer race facing in toward the *axis* of the axle. On an adjustable-cone hub, the bearing is adjusted by moving the cone on the axle so that it becomes closer to or further from the cup. In a cartridge-bearing hub, moving the inner race closer or further from the outer race could only be accomplished by expanding or shrinking the race, which is impossible since it is hardened steel. On the other hand it *is* possible to *mis-adjust* a cartridge bearing on a threaded axle. If the hardware on the axle just outside of the inner race is threaded onto the axle too far, it will *displace* the inner race from the correct orientation with the outer race, causing the ball bearings to bind between them. This happens because the balls ride in shallow troughs in each race. When the troughs do not line up with each other, the effective width of the channel they create together becomes narrower than the ball bearings.



13.1 *The side-load on the inner race of the right bearing cartridge causes contact to occur between the races and the ball bearings at inappropriate points (contact points indicated by arrows).*

The symptom created when the hardware is too tight against the inner race is that of a tight bearing. In the case that the axle is quick release (usually), the symptom may go away when the wheel is removed from the bike because of the nature of quick-release axles to expand when the load of the quick-release skewer is released. Therefore, a hub that is apparently fine when checked out of the bike could be over-tight in the bike (when there is no way to check it). Mavic hubs are an exception to this because they are designed to be adjusted while the wheel is mounted in the bike.

For this reason, adjusting the hub(s) is recommended for any new bike. On threaded-axle cartridge-bearing hubs, the only way to know that the hardware is not too tight is to adjust it. Most retail outlets assume the factory has done its job correctly, and don't check the adjustment. Factory adjustments are not very reliable. Hubs may be completely worn out after as little as 1000 miles of use, due to poor factory setup.

ABOUT THE REST OF THIS CHAPTER

From here on, this chapter is divided into nine sections. The sections are for servicing the SunTour type hubs, the Nuke Proof type hubs, Hügi hubs, Ringlè hubs, Phil Wood FSA hubs, White Industries hubs, and Chris King hubs. The final section is about tools for servicing cartridge-bearing hubs. Remember, the SunTour steps apply almost verbatim to certain Matrix, Specialized, Sanshin, and Performance hubs. The Nuke Proof steps apply *loosely* to American Classic, Bullseye, and Cook Bros. The remaining sections are completely specific to the hub each is written about.

SUNTOUR HUBS AND SIMILAR HUBS

As of the summer of 1995, the SunTour company has quit doing business in the U.S. This situation presents some potential service limitations. Fortunately, axles for SunTour hubs are not unique, and neither are the cartridge bearings. The sleeve nuts are the only unique part in this type of hub, and these are unlikely to wear out. Wheels Manufacturing of Boulder, Colorado, makes an item called the Dropout Saver DS-1 (used for replacing threads in a derailleur hanger) that is an adequate substitute. To use the Dropout Saver, a cone wrench would needed to be thinned down on the grinder, because the height of the wrench flats on the Dropout Saver is less than the thickness of any cone wrench.

TOOL CHOICES

The following table covers tools for SunTour-type cartridge-bearing hub(s) only.

SUNTOUR HUB TOOLS (table 13-1)

Tool	Fits and considerations
SunTour TA-340	Removes and installs bearing cartridges, no longer sold.
CalVan 28	Removes bearing cartridges only.

TIME AND DIFFICULTY RATING

Overhauling the hub, including freewheel removal and bearing replacement, is a 15–20 minute job of little difficulty. Adjusting the hub alone (including freewheel removal) is a 5–10 minute job of little difficulty.

COMPLICATIONS

Difficult bearing removal

If using the SunTour TA-340 removal tool, the tool sometimes pops out of the bearing before the bearing removes from the hub shell. This may happen because the tool being used to drive against the TA-340 is the wrong shape, or because the TA-340 has been distorted. The driving tool needs to be close in diameter to the hole in the middle of the bearing and should be completely flat on the ends. An old 10mm quick-release axle is adequate, but an 11mm round shaft with a flat end is better. See figure 13.10 (page 13-7).

Once the TA-340 removal tool is forced through the hole in the middle of the bearing, it becomes distorted and is more likely to push through again. Bend the tool so that the two ends are even and parallel.

Difficult bearing installation

Bearings are usually not difficult to install in this type of hub unless they become misaligned during installation. If the bearing, installation washer, and sleeve nut are assembled as a unit and kept together, this will not be a problem. Make sure that the bearing and installation washer are both on the sleeve of the sleeve nut before beginning installation. See figure 13.11 (page 13-9).

Mysterious squeals, clicks, and pops

Mysterious noises of these types usually occur only while riding the bike. They are caused by the bearing moving inside the hub shell, or by motion between the sleeve nut and the inner race of the bearing. The bearing cartridge is supposed to be a press fit to both the shell and the sleeve nut, so Loctite 222 or 242 should be used when these noises occur and there is evidence that the bearing is a loose fit inside or outside.

Lack of correct tools

The SunTour TA-340 tool set is no longer distributed by SunTour. For bearing removal, the CalVan 28 (United Bicycle Tool) is a good substitute. The SunTour tool set also comes with special washers for pressing in the bearings. These washers have a lip at the outer perimeter that presses against the outer race of the bearing without pressing on the inner perimeter. They also are slightly smaller in diameter so that they could drive the bearing inside the hub shell without getting stuck themselves. The best substitute for these washers is a pair of used bearings. Use a small grinding stone on a rotary or Dremel tool to recess the lip of the inner race of the old bearings by a small amount. Spin the outside of the old bearings against a grinding wheel for a moment to reduce their O.D.

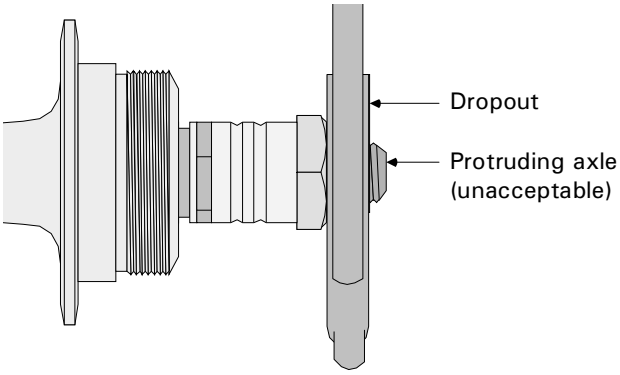
HUB-AXLE THREADS

Axle threads for these hubs (regardless of brand and whether the axle is solid or quick release) are 9mm × 1mm for the front hub and 10mm × 1mm for the rear hub. These diameters are nominal, the 9mm axle measures between 8.7–8.9mm and the 10mm axle measures between 9.7–9.9mm. The inside diameter of the nuts that fit on the 9mm axle will range from 7.8–8.1mm and the inside diameter of the nuts that fit on the 10mm axle will range from 8.8–9.1mm.

NOTE: If just adjusting hub and not overhauling it, do steps 1–7, then skip to heading* FINAL SETTING *just after step 66 (page 13-9).

COMPONENT REMOVAL AND PRE-DISASSEMBLY INSPECTION

1. **[ ] Remove wheel from bike and skewer (if any) from hub.**
2. **[ ] Place wheel back in dropouts.**



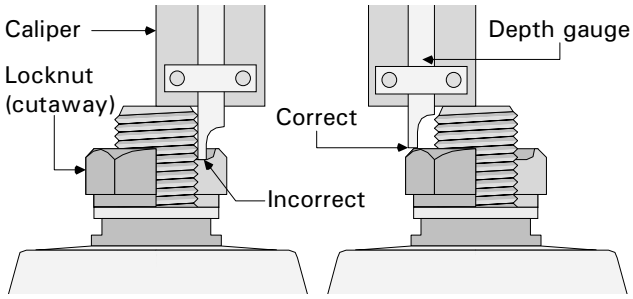
13.2 It is unacceptable for the quick-release axle to protrude beyond the face of the dropout.

3. **[ ] Observe wheel in bike and determine whether QR axles protrude beyond dropout faces.**
4. **[ ] If QR axles protrude, measure dropout thickness. This is maximum allowable axle protrusion. Maximum axle protrusion (dropout thickness) is: _____mm.**
5. **[ ] Rotate axle and check for oscillation at ends that indicates bends.**
6. **[ ] Rotate axle and feel for severe grittiness that indicates worn out parts or over-tight adjustment.**
7. **[ ] Remove freewheel (if any, for overhaul or adjustment) or freehub cogs (for overhaul only, not adjustment).**

In the next step, the correct axle protrusion will be determined (the distance the end of the axle protrudes beyond the face of the locknut that is found just inboard of the dropout). In most cases, the axle protrusion should be equal on both sides. One rare exception is when one dropout is thicker than the other (in which case the axle protrusions should differ by the amount that the dropout thicknesses differ). Certain inexpensive bikes have a plate of metal that the derailleur attaches to, which bolts onto the outer face of the right-rear dropout. This is called a bolt-on derailleur hanger. The bolt-on derailleur hanger is part of the dropout, so in this case consider the right dropout to be thicker than the left dropout by the thickness of the bolt-on hanger.

In the next steps, measure the two axle protrusions and average them to determine the correct axle protrusion. If there is a right-rear dropout that is thicker, add half the difference in thickness to the average axle protrusion for the correct right-side protrusion, and subtract half the thickness difference from the average axle protrusion for the correct left-side protrusion.

When measuring the axle protrusion, use the depth gauge of a caliper and measure from the high point on the face of the locknut to the end of the axle. Some axles have a recess in their face. *Do not measure down into any recess.*



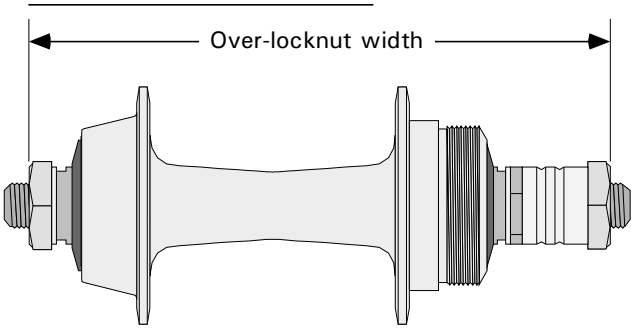
13.3 *Measuring the axle protrusion.*

Determine correct axle protrusion:

8. [ ] Right-side axle protrusion: _____mm
9. [ ] Left-side axle protrusion: + _____mm
10. [ ] Total axle protrusion is: = _____mm
÷ 2
11. [ ] AVG. AXLE PROTRUSION IS: = _____mm

Measure over-locknut width

In the next step, measure the overall width from the left locknut to the right locknut. This measurement is needed if replacing any parts on the hub with non-exact replacements. If some sort of substitute part that is not the same effective width as the original is used, it could affect the fit of the wheel to the frame or fork. By knowing how much the final width differs from the original width, it will be known how many washers to add or subtract on the side of the hub where the substitute part was installed.

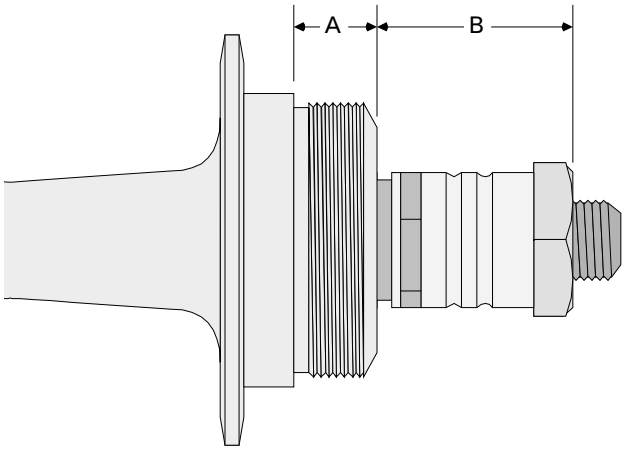


13.4 *Measuring the over-locknut width.*

12. [ ] Measure over-locknut width.
OVER-LOCKNUT WIDTH IS: _____mm

NOTE: Front hubs skip to step 17.

Step #13 through #16 apply to rear hubs only. The purpose of these steps is to get a measurement that corresponds to the distance the freewheel or freehub cogs sit from the dropout. This distance must be maintained when overhauling the hub or the rear derailleur might need adjustment or the freewheel may not even have enough room to be re-installed. The measurement will not be needed unless replacing right-side parts with non-identical parts, or if left-side and right-side parts get mixed up.



13.5 *Measure freewheel space by adding these two measurements together.*

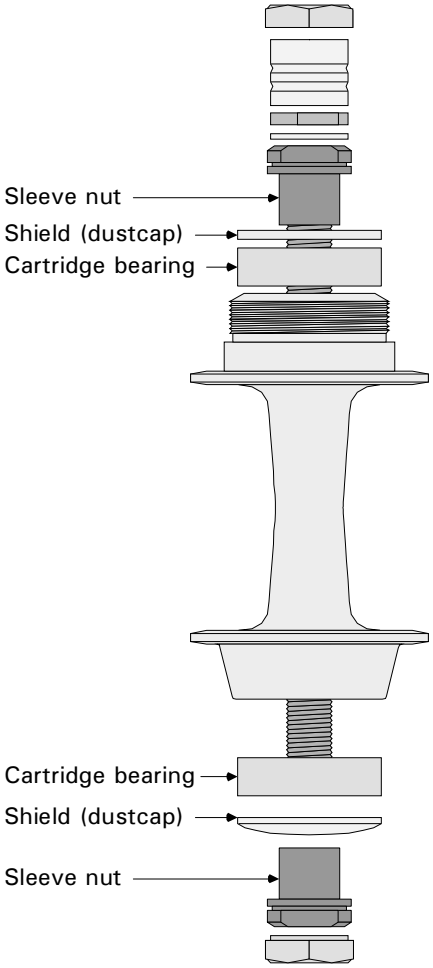
NOTE: Skip to step 16.

Thread-on-freewheel rear hubs only, measure and calculate freewheel space

13. [ ] Freewheel shoulder to end-of-shell: _____mm
14. [ ] End-of-shell to locknut face: + _____mm
15. [ ] FREEWHEEL SPACE: = _____mm

NOTE: Skip to step 17.

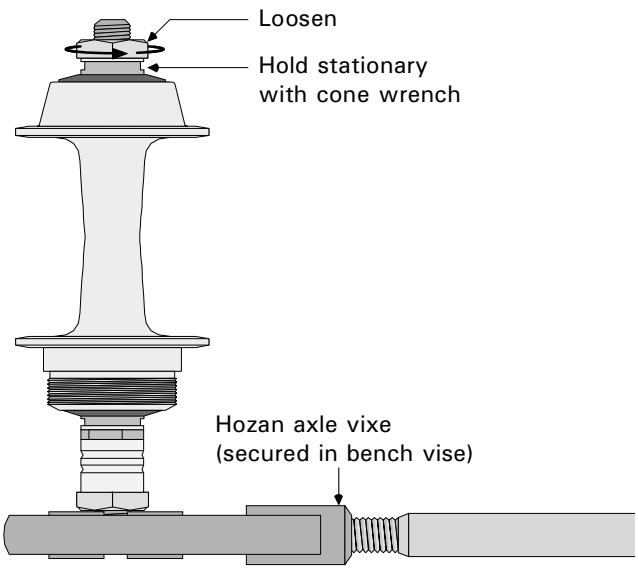
16. [ ] For freehubs, measure from end of freewheel-mechanism body (where cogs came off) to locknut face.
FREEHUB SPACE IS: _____mm



13.6 A SunTour cartridge-bearing hub.

DISASSEMBLY

Disassembling the first end of the axle is a lot easier if the axle is not free to turn. The ideal way to do this is to have the end of the axle that is not being disassembled held in a bench vise. When securing the axle in a vise, it is easy to damage either the axle or the locknut. If the axle is a not-quick-release type, there is enough axle to grasp securely with the axle directly in "soft jaws." Soft jaws are inserts made of aluminum, copper, plastic, or wood that cover the face of the vise jaws. All of these materials are softer than the axle threads so the axle threads will not be damaged. Quick-release axles do not protrude far enough to get a good grip with soft jaws, which might lead to clamping the vise tighter, which could crush the hollow quick-release axle. For this reason, a special axle-vise is required for use with quick-release axles. Grasping the axle by the locknut can lead to damage of the locknut.

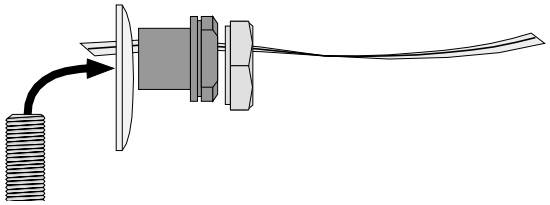


13.7 With the hub secured in a Hozan axle-vise, use a cone wrench to hold the inner nut while breaking loose the locknut.

17. [ ] Clamp *right* end of QR axle in axle-vise, or *right* end of solid axle in soft jaws.

18. [ ] Hold left inner nut stationary with cone wrench while breaking loose left locknut with adjustable wrench. (Use cone wrench only if locknut is round.)

There are few standards about the number and sequences of parts on the end of the axle. Furthermore, keeping left-side and right-side axle parts separate is critical on rear hubs (front hubs usually have symmetrical parts). For this reason, transfer parts directly from the axle to a bundling tie (wire or plastic bread-bag ties work) one at a time. Some parts, particularly outer locknuts, have a certain way they need to face, so it is just as important to maintain the specific orientation of each part as it comes off the axle as it is to maintain the order.



13.8 Transfer the parts one-by-one from the end of the axle to a bundling tie to maintain the correct order and orientation.

19. [ ] Thread left-end parts off axle and onto bundling tie while maintaining order and orientation. If hub rises up as inner nut is turned (called a sleeve nut because of sleeve that extends inside bearing), push down firmly on wheel to get it free of sleeve nut.

20. [ ] Lift hub off axle. It may require a bit of a jerk to get it to release from lower sleeve nut.

Steps #21 through #24 remove the right-side axle parts. This enables checking for a bent axle, damaged threads, and to reset the right-side axle protrusion if necessary. The tendency is to skip these steps but some important problems could be missed, especially if this is the first time overhauling this hub.

In these steps, put the right-side parts onto two bundling ties. This will enable keeping track of the left-side (first off, single tie) and right-side (second off, two ties) parts.

21. [ ] Reverse axle in axle-vise or soft jaws.

22. [ ] Hold sleeve nut (or lower locknut of double-locknut hub) stationary with cone wrench while breaking loose locknut with adjustable wrench. (Use cone wrench if locknut is round.)

23. [ ] *If double-locknut hub:* hold sleeve nut stationary while breaking loose lower locknut.

24. [ ] Thread right-end parts off axle and onto two ties, while maintaining order and orientation.

Some models of this hub may have a metal dustcap between the sleeve nut and the bearing. The dustcaps are symmetrical on front hubs, but rear hubs usually have different dustcaps on the right and left sides. If there is confusion as to which dustcap goes on which side, the right one is usually less "attractive" then the left one. The left one may have a brand name on it, and will have a shiny polished finish.

25. [ ] Remove metal dustcaps, if any, from bearings and attach to appropriate bundles.

Next, either remove the bearing seals in order to clean and regrease the inside of the bearing cartridges, or remove the bearing cartridges in order to replace them. The act of removing the cartridges involves impacts that can destroy the bearing. Never attempt cartridge-bearing removal unless planning to replace the bearings and it is known where to get replacements. There are numbers on the seal that indicate the bearing type to help find replacements, if needed. On most models the number is 6001.

26. [ ] Rotate inner races to inspect their condition and decide whether to attempt cleaning and regreasing or full replacement of cartridges.

Regreasing bearing cartridges

NOTE: If replacing, skip to step 31.

If, when rotating the inner race of the bearings, they feel rough or sluggish, they may need cleaning and regreasing, or replacement may be required. If they don't feel good after cleaning and regreasing they will need to be replaced.

If just wanting to clean and regrease the bearings, they should be left in the hub. Removing the seals is a little tricky, but it can be done. The seal looks like black rubber, but actually it is a flat metal ring pressed into the outer race and coated with rubber. At its inner perimeter, there is a rubber lip that a small screwdriver or seal pick can pass by and catch under the metal ring in order to lift it out. The metal ring is easily bent, so pry gently and try prying at several points right next to each other if the seal does not lift right out. If it is only bent a little bit, it can be flattened and reused.

13.9 Removing the seal from the bearing.

27. [ ] *Gently* insert tip of a 1/8" slotted screwdriver or seal pick under soft lip at inner perimeter of black rubber seal on face of bearing and lift out seal.

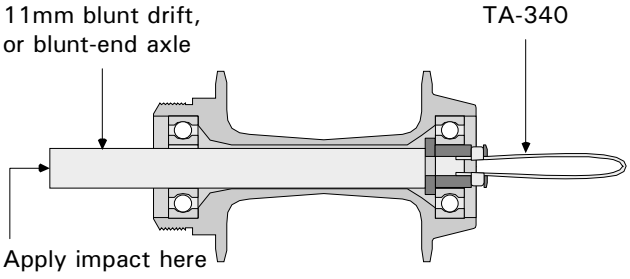
28. [ ] Clean grease out of bearing area with solvent and a toothbrush and dry thoroughly.

29. [ ] Pack bearings with grease and press seals back in.

30. [ ] Skip to heading INSPECTION.

Removing bearing cartridges

31. [ ] Insert removal-tool portion of SunTour TA-340 tool set into either of bearings so that lips catch behind bearing.



13.10 Driving out the bearing cartridge.

32. [ ] Insert axle from opposite side of hub against inward end of removal tool and tap on axle with a ball peen hammer to drive tool and bearing out of hub.

33. [ ] Look for a spacing washer (only some models) in hub shell that was behind the bearing and attach it to appropriate parts bundle.

34. [ ] Repeat steps 31–33 for second side.

The next step only applies to rear freehubs, and is optional. The hub can be cleaned with the freehub body still attached. It makes for extra work when drying after cleaning. Techniques for freehub-body removal are not covered here, as they are optional and *are* covered as part of the **FREEHUB MECHANISMS AND THREAD-ON FREEWHEELS** chapter (page 25-18).

35. [ ] Only if working on rear freehub, remove freehub body (optional).

36. [ ] Clean all parts, including outside of hub shell.

INSPECTION

Hub-shell damage with regard to the bearings is rare. Primarily this will occur if the original tolerances were poor and the bearing cartridge was a loose fit in the hub shell. Loose bearing cartridges would have been noticed during bearing removal, or before even attempting removal. The hub shell is now oversized, but the problem can be solved by reinstalling the bearing cartridge with Loctite 242.

37. [ ] If bearing cartridges have been regreased, turn inner race to feel for any roughness. If they are rough they should be replaced. Return to step 31.

38. [ ] Inspect fit of bearing cartridges to hub shell. Good (tight)? Bad (loose)?

The sleeve nuts are supposed to be a mild press fit inside the bearing cartridges. If they slip in and out effortlessly, or if the outside of the sleeve on the sleeve nut has a polished appearance, the fit is bad. It can be corrected by using Loctite 242 between the sleeve nut and the bearing.

39. [ ] Inspect sleeve nuts for looseness in bearing cartridges. Good? Bad?

Next, inspect the axle for bends. Roll the axle on a flat smooth surface such as a Formica counter top or a glass counter. Look under the axle as it rolls for a humping up and down that indicates the axle is bent. A bent axle is an axle in the process of breaking, and should be replaced. A bent axle can be caused by misaligned dropouts, so check the dropouts. Axles can also bend from severe impact to the wheel or high pedaling loads.

40. [ ] Inspect axle for bends. Good? Bad?

Threads can be damaged on the axle from getting nicked, or from excess torque on a locknut, which results in stripped threads. If the threads are nicked from impact, they can be repaired with the thread file. Threads stripped from an over-tightened locknut cannot be repaired. Replace the axle.

41. [ ] Inspect axle for damaged threads. Good? Bad?

42. [ ] Inspect locknuts for damaged threads, cracks, warpage, and rounded off flats. Good? Bad?

ASSEMBLY

If installing a new axle, the length does not have to match exactly. For quick-release axles, the minimum axle protrusion per side should be no less than one-half the dropout thickness, and the maximum should be no more than the dropout thickness. For non-quick-release axles, the minimum length should be no less than the sum of the dropout thickness, plus the thickness of the washers under the axle nuts, plus the thickness of the axle nuts.

NOTE: If not replacing axle with a new one of different length skip to step 46.

Calculate new axle protrusion

43. [ ] Measure difference between axle lengths.
Difference is: _____mm
Divide by two: ÷2
1/2 difference is: =_____mm

44. [ ] Repeat original average axle protrusion here (from step 11): _____mm

45. [ ] If new axle is shorter, subtract (or if longer, add) the difference from/to old protrusion.
NEW AVG. PROTRUSION IS: =_____mm

46. [ ] Replace bad parts on bundles with good parts.

Freehub-body installation

If the freehub body was removed in step #35, it is time to install it. Be sure it is dry and oiled inside. Techniques for cleaning, drying, oiling, and installation are all covered in the **FREEHUB MECHANISMS AND THREAD-ON FREEWHEELS** chapter (page 25-??).

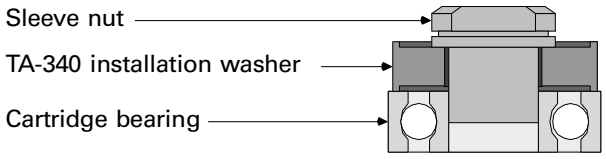
47. [ ] Install freehub body if it was removed in step 35.

NOTE: Hubs with bearing cartridges already installed skip to step 56.

Installation of the cartridge bearings

Bearing cartridges sometimes have the same seal on both faces, and sometimes the seals are different. In general, the black rubber seal should face out when the bearing cartridge is installed. In the next step, the sleeve nuts, axle, and the black washers from the TA-340 tool set combine to form a bearing-cartridge installation tool. If used properly, the set-up guarantees that cartridges go in straight and do not bind. The key to this is having the sleeve nut *inside* the bearing cartridge during installation.

48. [ ] Secure vise on flats of sleeve nut, with sleeve pointing up.
49. [ ] Thread axle into sleeve nut.
50. [ ] Slip TA-340 washer and then bearing cartridge over sleeve. Install bearing-spacer washer (if any) on top of bearing. It may be necessary to use a little force to get bearing cartridge onto sleeve nut.



13.11 Assemble the TA-340 installation washer and the bearing cartridge to the sleeve nut.

51. [ ] Place hub on axle, resting on bearing.
52. [ ] Install other bearing-spacer washer (if any) into hub shell.
53. [ ] Slip other TA-340 washer and then other bearing cartridge over other sleeve nut. It may be necessary to use a little force to get bearing cartridge onto sleeve nut.
54. [ ] Thread sleeve-nut/washer/bearing assembly onto axle and use wrench on sleeve nut to press bearing cartridges fully into hub.
55. [ ] Unthread sleeve nuts from axle and return sleeve nuts to parts bundles.

Set right-side axle protrusion

56. [ ] Grease axle threads.
57. [ ] Install axle in axle-vise or soft jaws with right end up. (Right end is longer-threaded end if right parts bundle is bigger bundle, or shorter-threaded end if right parts bundle is smaller bundle.)

When disassembling an axle set, the assumption is that all parts are in the correct orientation. If the parts are not in correct orientation, or if the bundle came apart during cleaning and the parts orientation is uncertain, make sure the outer locknuts go on correctly. If one side of the locknut is flat and smooth and the other side is not, then the non-smooth side faces out, so as to grip the inside face of the dropout and hold the wheel more securely in the bike.

58. [ ] Transfer all parts from right-side bundle (two ties) to axle.
59. [ ] Position top locknut so axle protrusion equals average axle protrusion plus .2mm.
60. [ ] Hold top locknut stationary with wrench and tighten parts below it snugly up against locknut.
61. [ ] Measure axle protrusion and adjust if necessary.
62. [ ] Loosen axle-vise (or vise) slightly, so that axle is free to turn.
63. [ ] Hold sleeve nut with cone wrench and torque locknut to 120–180in-lbs (30–45lbs@4").

Install axle in hub

64. [ ] Turn axle over.
65. [ ] Drop hub (right-side down) onto axle assembly.
66. [ ] Transfer left-side parts bundle to axle. It may be necessary to press hub down onto lower sleeve nut to have enough room to install left-side parts.

FINAL SETTING

The final setting is different if the hub has a quick-release axle, than it is if the hub has a solid axle (wheel held on by axle nuts). The reason for this difference is that the force of closing down a quick-release lever compresses the axle, making any out-of-the-bike adjustment of the hub that is perfectly adjusted overtight once the wheel is in the bike. There are two procedures for the final setting; whether the hub has a quick-release axle or a solid axle determines which procedure to follow.

If axle is non-quick release

NOTE: If axle is quick release type skip to step 70.

67. [ ] Turn sleeve nut in clockwise until both sleeve nuts bottom against bearings.
68. [ ] Back sleeve nut out counterclockwise 45° (one-eighth turn).
69. [ ] Holding sleeve nut stationary with cone wrench, secure locknut to 120–180in-lbs (30–45lbs@4").

If axle is quick release

NOTE: Skip to step 73 for non-quick-release axles.

70. [ ] Turn sleeve nut in clockwise until both sleeve nuts bottom against bearings.
71. [ ] Back sleeve nut out counterclockwise 90° (one-quarter turn).
72. [ ] Holding sleeve nut stationary with cone wrench, secure locknut to 120–180in-lbs (30–45lbs@4").

Completion

73. [ ] Remove wheel from vise, install freewheel or freehub cogs (if any), install wheel normally.

NUKE PROOF AND SIMILAR HUBS

This section is written primarily about Nuke Proof hubs, but applies as well to other varieties that are similar, including Suzue, Bullseye, American Classic.

TOOL CHOICES

The design of the Nuke Proof hub requires only a 3/64" size Allen wrench. The Bullseye hub requires a 5/64" Allen wrench. A drift punch is also needed to remove one of the bearings.

In addition, a plastic mallet and a variety of other common tools are used.

TIME AND DIFFICULTY RATING

Overhauling a Nuke Proof style hub, including freewheel removal and bearing replacement, is a 10–15 minute job of little difficulty.

COMPONENT REMOVAL AND PRE-DISASSEMBLY INSPECTION

1. [ ] **Remove wheel from bike and skewer (if any) or wheel mounting bolts from hub.**
2. [ ] **Rotate axle and feel for severe grittiness that indicates worn out parts.**
3. [ ] **Remove freewheel if overhauling hub.**

DISASSEMBLY

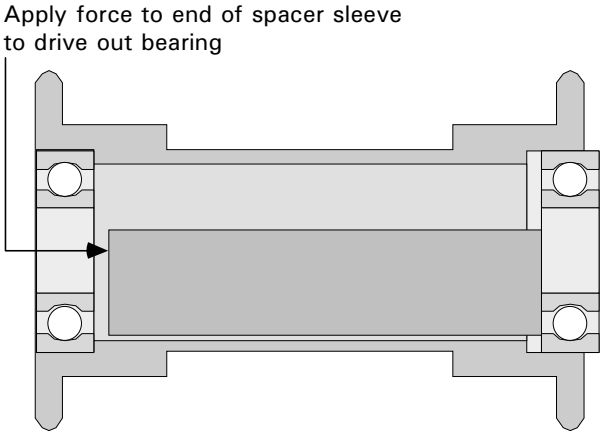
Of the varieties of hubs that this section covers, almost all have some sort of cap or spacer: one that slips onto the end of the axle. This cap may be retained by a set screw, or it may simply slip on and be held in place by the dropouts, once the wheel is mounted in the frame.

The one exception to this approach are Suzue hubs. These have a threaded axle and a pair of locknuts (with spacers between them) that are locked together on each end of the axle just outward of the bearings. A wrench and cone wrench would be used to unlock the locknuts from each other so the axle can be made bare outward of the bearings.

4. [ ] **Loosen set screws on right-side spacer cap on end of axle, slip spacer cap off axle, and slip off any spacer washers. Bundle all these parts together on a tie.**
5. [ ] **Repeat step 4 for left side.**
6. [ ] **Tap on either end of axle to drive out axle and one bearing. A shoulder on the axle bears against the bearing to drive it out.**

The Bullseye hub is an exception to the above step. There are no shoulders on the axle, so when it is tapped out the bearings remain in place. A spacer sleeve that goes around the axle and between the bearings will drop to one side when the axle is removed. A drift punch can be used through one bearing against the end of the spacer sleeve in order to drive the first bearing out. A punch or the CalVan 28 can be used to drive the remaining bearing out.

7. [ ] **Turn inner race on each cartridge bearing to inspect bearing condition.**



13.12 *Bullseye bearing unit removal.*

NOTE: Skip to step 11 for all hubs except Bullseye.

Regreasing Bullseye bearing cartridges

If the bearings feel rough, there is an option of cleaning and regreasing them, or replacing them. Impact is required to remove the bearings, so once they are removed, they must be replaced. If cleaning and regreasing does not eliminate the roughness, replacement is the only option.

If the inner race of the bearings feel rough or sluggish when rotated, they may need cleaning and regreasing, or they may need replacement. If they don't feel good after cleaning and regreasing, replacement is required.

If only cleaning and regreasing the bearings, they should remain in the hub. Removing the seals is a little tricky, but it can be done. The seal looks like black rubber, but actually it is a flat metal ring pressed into the outer race and coated with rubber. At its inner perimeter, there is a rubber lip that a small screwdriver or seal pick can pass by and catch under

the metal ring in order to lift it out. The metal ring is easily bent, so pry gently and try prying at several points right next to each other if the seal does not lift right out. If it is only slightly bent, it can be flattened and reused.

13.13 *Removing the seal from the bearing.*

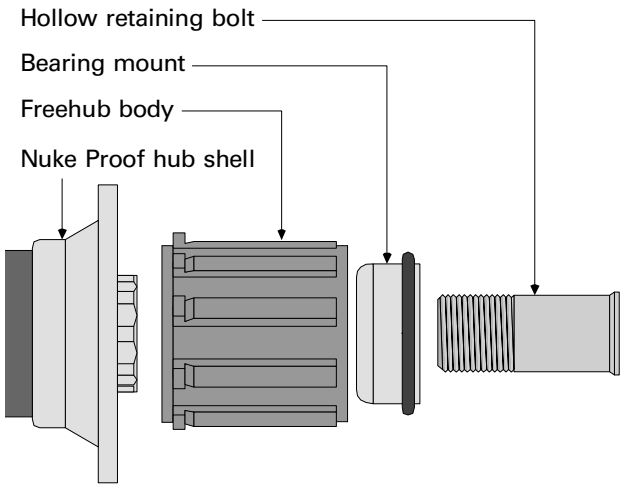
8. [ ] *Gently* insert tip of a 1/8" slotted screwdriver or seal pick under soft lip at inner perimeter of black rubber seal on face of bearing and lift out seal.
9. [ ] Clean grease out of bearing area with solvent and a toothbrush and dry thoroughly.
10. [ ] Pack bearings with grease and press seals back in.

Removing other bearing cartridge

Removing bearings may damage them beyond reuse, so do not remove them unless prepared to replace them. There should be a four digit number on the bearing seals that is the identification number for the bearings.

11. [ ] To remove bearing that was driven out with axle, support bearing on vise jaws and tap axle down out of bearing.
12. [ ] Insert axle in hub and drive out left-side bearing. Remove second bearing from axle.
13. [ ] Clean all parts, including outside of hub shell. Clean bearing mating surfaces of any corrosion, remnants of Loctite, grease, and dirt.

The Nuke Proof freehub has a bearing mount inside the freehub mechanism. There is no need to remove this for normal bearing service. It is retained by the same hollow bolt that holds the freehub to the hub shell. Use a 10mm Allen wrench to remove the bolt and the cartridge-bearing mount will come out of the freehub mechanism, and the freehub mechanism will be free to slip off the hub shell.



13.14 *Freehub-body removal from a Nuke Proof hub.*

ASSEMBLY

Installing the cartridge bearings and axle

14. [ ] Place axle (axle and spacer sleeve if Bullseye hub) inside hub shell.
15. [ ] Slide bearings onto each end of axle.

In the next step, load needs to be placed against the face of the bearings. Although it is possible to install them by tapping around their perimeter with a plastic mallet, this method can cause them to misalign and jam.

A better method is to devise some sort of support cylinder and driving cylinder. The perfect driving cylinder for the Nuke Proof hub is a pair of Shimano TL-FW30 freewheel removers. The diameter of the splined end of these tools closely matches the diameter of the Nuke Proof bearings and allows the pressure to be born by the outer races only. The length of these tools allows the axle to be cleared whether working on a front or rear hub.

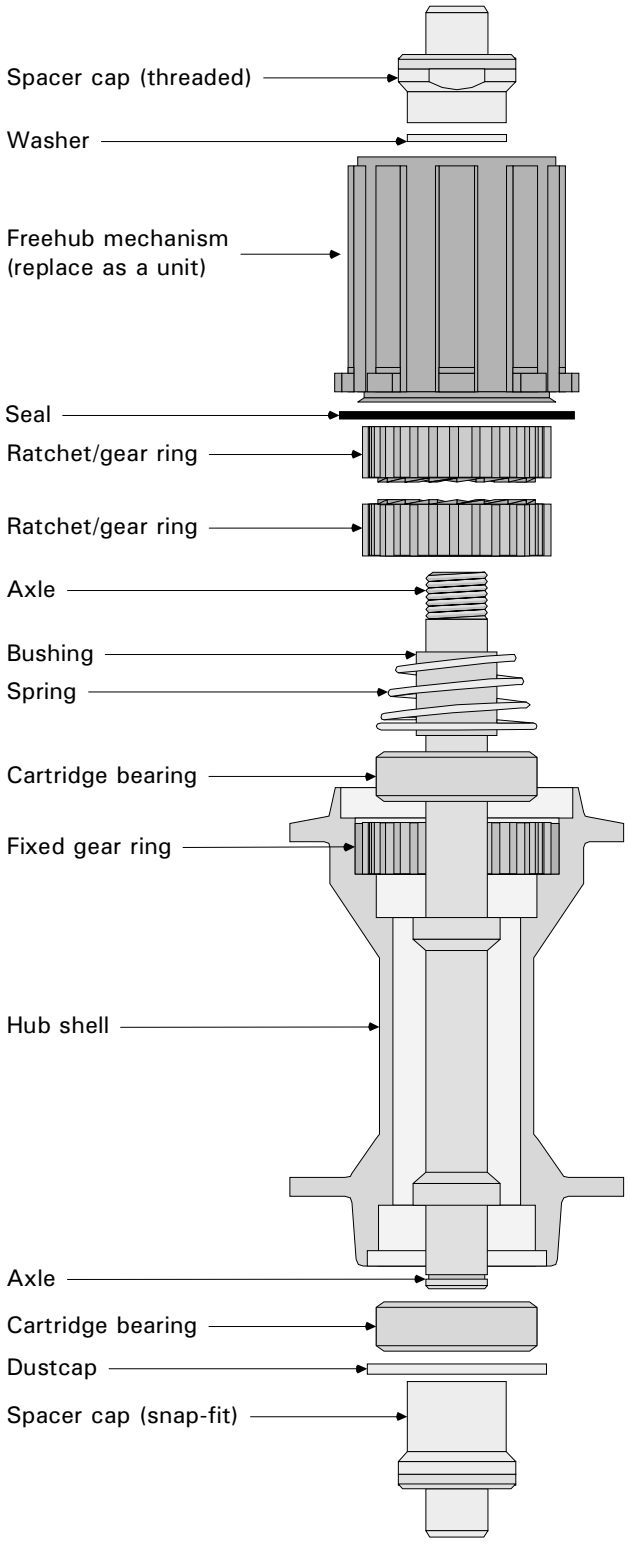
16. [ ] Support one end of hub on support cylinder and use another cylinder to drive in upper bearing until both bearings are fully inserted.
17. [ ] Turn axle to feel if bearings are binding. If binding, tap alternately on opposite sides of axle until bearings turn smoothly.
18. [ ] Install caps/spacers on ends of axles.

Completion

19. [ ] Install freewheel or freehub cogs (if any), install wheel normally.

HÜGI FREEHUBS

This section is about Hügi freehubs. These hubs exist in several design variations, but most varieties are similar to this example.



13.15 *A Hügi freehub.*

TIME AND DIFFICULTY RATING

Overhauling the hub including cog removal and bearing replacement is a 15–20 minute job of little difficulty.

DISASSEMBLY

1. [ ] **Remove cogset from hub.**
2. [ ] **Pull spacer cap off left end of axle (hold spacer cap in vise soft jaws if necessary).**
3. [ ] **Hold left end of axle in 10mm smooth jaw axle vise (fabricate larger diameter clamp blocks for other axle size).**
4. [ ] **Use 17mm cone wrench to unthread right-side spacer cap.**
5. [ ] **Pull freehub mechanism off axle.**
6. [ ] **Remove small washer from inside bearing dustcap on outboard face of freehub mechanism.**
7. [ ] **Remove ratchet/gear ring from back face of freehub mechanism.**
8. [ ] **Remove ratchet/gear ring, spring, and metal bushing from right end of axle.**
9. [ ] **Carefully remove seal from right side of hub shell.**

When removing the bearing in step #10, it is important to support the hub shell in a way that will protect it. A simple support for the hub shell can be made out of a section of PVC pipe with a 1–9/16" inside diameter.

10. [ ] **Tap right end of axle with soft hammer to drive bearing and dustcap out of left side of hub shell.**
11. [ ] **Remove bearing from left end of axle.**
12. [ ] **Insert axle back into hub shell, and drive bearing out right side of hub shell.**

ASSEMBLY

13. [ ] **Place axle into hub shell with longer end on right.**
14. [ ] **Place bearings on each end of axle.**

When removing pressing the bearings in step #15, a support cylinder (under the lower bearing) and a driving cylinder are needed. These cylinders can be fabricated from a 1" fork column, or from the center section of a handlebar that has a 1" O.D.

15. [ ] **Place right side of hub down on top of 1" cylinder (section of fork column, or section of handlebar center).**
16. [ ] **Place second 1" cylinder on top of left-side bearing and align it carefully to bearing.**
17. [ ] **Tap on upper cylinder to simultaneously press in both bearings fully.**
18. [ ] **Mount left end of axle in axle vise.**

19. [ ] **Place seal ring over lip on inward end of freehub mechanism so that metal side of ring will face hub shell.**
20. [ ] **Grease metal bushing and place over right end of axle.**
21. [ ] **Place conical spring over metal bushing, small end facing out.**
22. [ ] **Grease one ratchet/gear ring and place in right end of hub shell with toothed-face facing out.**
23. [ ] **Grease other ratchet/gear ring and place in inside end of freehub mechanism so that toothed face faces out of freehub mechanism.**
24. [ ] **Slide freehub mechansim onto right end of axle and press firmly to seat seal inside hub shell (some rotation may be required to align teeth on ratchet/gear ring, and inner ratchet/gear ring may need to be poked with a finger to get it to center up).**
25. [ ] **Place washer over right end of axle.**
26. [ ] **Treat right-side spacer cap threads with Loctite 242, then gently secure cap on right end of axle.**
27. [ ] **Use tip of 3/16" slotted screwdriver to press seal down (accessible through each groove in freehub mechanism).**
28. [ ] **Remove hub from axle vise and support right-end down on surface.**
29. [ ] **Use 1" cylinder to gently tap left side dustcap into left end of hub shell.**
30. [ ] **Tap left-side spacer cap onto left end of axle.**
31. [ ] **Install cogs.**

RINGLÈ FREEHUBS

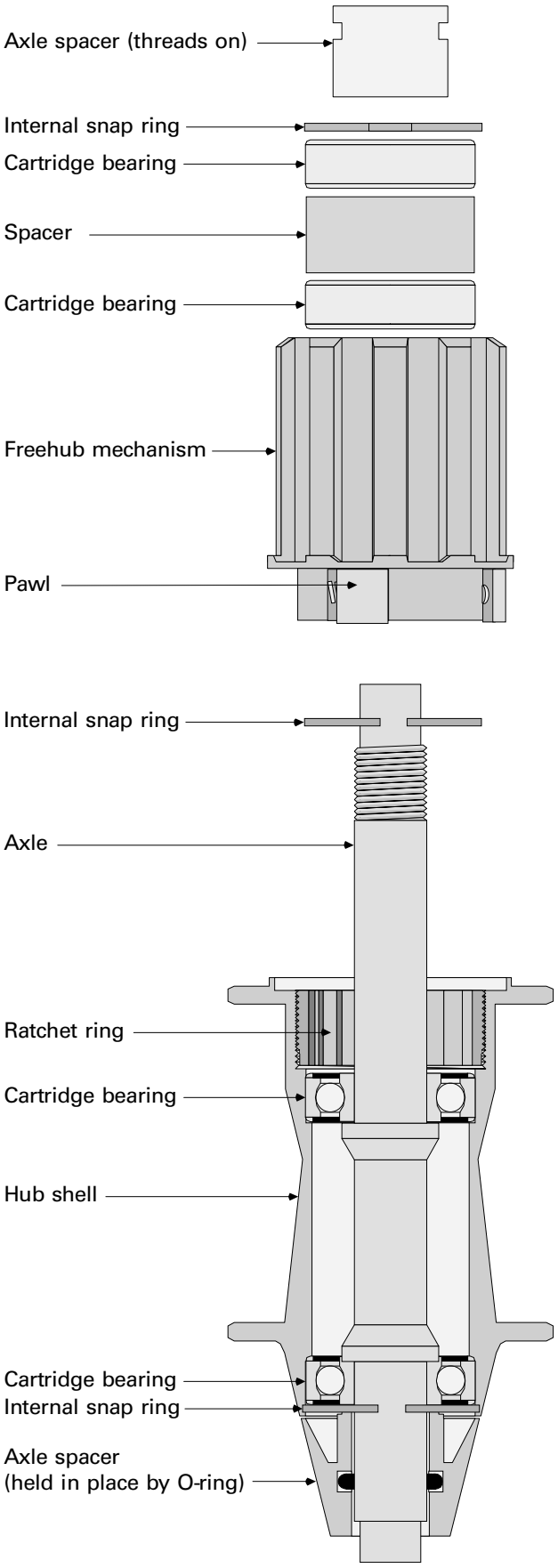
TOOL CHOICES

In addition to common bicycle mechanic's tools, the following tools will be needed.

Ringlè bearing tool kit including:
a) Bubbahub bearing driver with 24mm O.D. driving surface (for front hub),
b) Superbubba bearing driver with 27.5mm O.D. driving surface,
c) Large Diameter Tool, which is 47 × 57mm cylinder with 1/2" hole on one side and large 35mm cavity on other side. A 2–1/4" length of 2–1/4" O.D. PVC pipe works.

Bicycle Research Sealed Bearing Remover Kit (Substitute White Industries removers)

White Industries bearing press.



13.16 *A Ringlè freehub.*

DISASSEMBLY

1. [ ] **Pry under edge of left-side axle spacer to remove it.**

Older models lack the snap-ring referred to in the next step, or the other snap-ring referred to adjacent to the right-side hub bearing.

2. [ ] **Remove internal snap-ring from left end of hub shell.**
3. [ ] **Mount left end of axle in smooth radius axle-vise and secure.**

Older models lack the 16mm flats for the cone wrench mentioned in the next step. Use a small adjustable pin spanner or snap-ring pliers in the pin holes in the face of the nut instead.

4. [ ] **Use 16mm cone wrench to remove spacer nut from right end of axle.**
5. [ ] **Thread cog lockring into freehub body, put freehub body between vise jaws so that flange of lockring keeps hub from dropping, then tap on axle with plastic mallet to separate freehub body from hub shell (remove pawls and springs).**
6. [ ] **Place 2–1/4" section of 2–1/4" PVC pipe on bench, then place left side of hub into pipe.**
7. [ ] **Strike right side of axle with plastic mallet to remove left-side bearing.**
8. [ ] **If old axle will be reused, remove bearing from axle. Support bearing and tap axle with plastic mallet to remove.**

Inner right-bearing removal

Older models have a smaller-diameter ratchet ring, which will not allow the bearing to pass through. This must be unthreaded before with a special Ringlé tool before the right bearing can be removed.

9. [ ] **Remove internal snap-ring from inside of right end of hub shell.**
10. [ ] **Install 15mm Bicycle Research Bearing Remover (insert from left) into right bearing, then secure with expansion ring positioned inside bearing. Alternatively, use 15mm White Industries Bearing Extractor, installed from right).**
11. [ ] **Support right side of hub on PVC pipe.**
12. [ ] **Tap on shaft to remove bearing.**

Bearing removal from freehub body

13. [ ] **Remove internal snap-ring in right end of body using snap-ring pliers.**
14. [ ] **Insert 12mm Bicycle Research Bearing Remover into outward bearing (insert from inward end), then secure tool. Alternatively, use 12mm White Industries Bearing Extractor inserted from outer end.**
15. [ ] **Place old splined cassette cog on freehub body and place body with right-side down in vise using soft jaws to gently hold body.**
16. [ ] **Tap on shaft to drive bearing downward.**
17. [ ] **Insert 15mm Bicycle Research Bearing Remover into remaining bearing from inner end of freehub body, then secure tool. Alternatively, use CalVan 28 tool to extract bearing (White Industries tool will not fit).**
18. [ ] **With freehub body supported in vise (resting on cog), tap on tool to remove bearing and spacer sleeve.**
19. [ ] **Loosen tool bolts and remove bearing from tool (it may be necessary to tap tool out of bearing).**

ASSEMBLY

Install bearings in freehub body

20. [ ] **Secure White Bearing Installer in vise, threaded end up.**
21. [ ] **Place large spacer, freehub body (open-end up), 28 × 15mm (O.D. × I.D.) bearing, aluminum sleeve, and then 28 × 12mm bearing onto tool shaft.**
22. [ ] **Place large spacer and handle/bearing assembly onto tool, then tighten until bearings are fully pressed into freehub body.**
23. [ ] **Unthread tool handle and remove freehub body from tool shaft.**
24. [ ] **Put internal snap-ring into end of freehub body.**

Install right-side hub bearing

25. [ ] **Place large spacer and hub shell (left side first) onto tool shaft.**
26. [ ] **Place 32 × 15mm bearing into right side of hub shell.**
27. [ ] **Place large spacer on tool, then thread on handle/bearing assembly and tighten handle until bearing is fully seated.**
28. [ ] **Unthread handle and remove hub from tool and tool from vise.**
29. [ ] **Install large internal snap-ring in hub just past ratchet ring.**

Install axle and left-side bearing

30. [ ] **Place right side of hub on top of PVC tube.**
31. [ ] **Insert right end of axle (threaded) down into hub shell and tap axle gently with mallet until axle shoulder for left bearing is even with bearing shoulder in left end of hub.**
32. [ ] **Place new left-side bearing over axle, then use Ringlé bearing driver to install left-side bearing. Alternatively, use a hollow cylinder with an O.D. of 26–27.8mm.**
33. [ ] **Install internal snap-ring in left end of hub shell.**

Install freehub body, axle spacers, and nuts

34. [ ] Hold left side of axle using smooth radius jaw axle-vise.

35. [ ] Lubricate pawls of freehub with light oil and install pawls and springs.

In the next step, a hard-to-find tool by Campagnolo is recommended to hold the pawls compressed during freehub-body installation. Alternatively use a rubber band with a thickness 1/8" or less, and a length of 2–3". Wrap the rubber band once around the pawls, give it a single twist, then wrap all the slack around the splined body.

36. [ ] Use Campy clip (or rubber band) to hold pawls compressed.

37. [ ] Install freehub onto right side of axle. Turn freehub counterclockwise to engage pawls into ratchet ring, then withdraw Campy clip (or rubber band).

38. [ ] Lubricate threads of spacer nut and install on right side of axle.

39. [ ] Secure spacer nut to equivalent of 60in-lbs (10lbs@6").

40. [ ] Install left-side axle spacer.

PHIL WOOD FSA HUBS

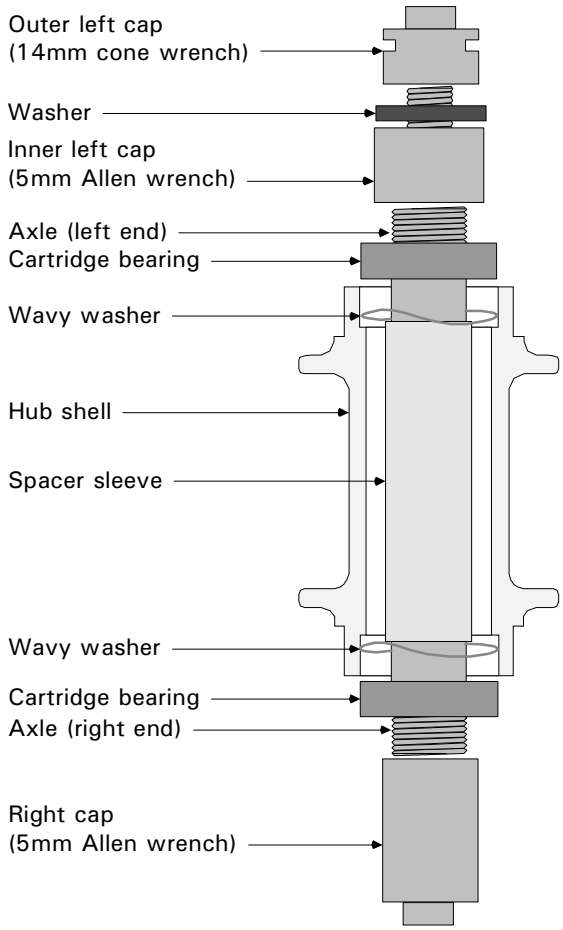
Phil Wood FSA hubs are unique in that the axle and bearings can be removed with nothing more than a 14mm cone wrench and a 5mm Allen wrench. No impact or pressure is supposed to be required to get the bearings or the axle in or out.

This ease of disassembly relies on the assumption that all the parts are adequately lubricated to prevent corrosion. Once corrosion sets in, disassembly can be very difficult, if not impossible. It would be worthwhile to disassemble and grease everything on a new hub.

DISASSEMBLY

In the next step, a cap is removed from one end of the axle. If the hub is a rear hub, there will be a double cap on the left end. The two left caps may remain locked together, in which case the right cap will unthread. The following procedure assumes that the two left caps will remain locked together, and it is the right cap that will come off.

Another possibility is that the outer left cap will break loose from the inner left cap, in which case the axle will still be trapped in the hub. The inner left cap has a 5mm Allen fitting in the end. This allows the use of two 5mm Allen wrenches to remove either of the caps from the axle.



13.17 Representative Phil Wood FSA hub. Number and thickness of spacers may vary. Front hubs are symmetrical both sides and configured like right side of illustrated hub.

1. [ ] Holding left end of axle with 14mm cone wrench (rear) or 5mm Allen (front), use a 5mm Allen wrench to loosen right-side axle cap.

2. [ ] Unthread cap from right end of axle.

3. [ ] Pull axle assembly out left end of hub.

4. [ ] Use axle to poke bearing out of right end of hub shell.

5. [ ] Find wavy washers that were between bearings and hub shell (on both sides) and remove.

6. [ ] Slide spacing sleeve off axle.

7. [ ] Slide left-side bearing off axle.

ASSEMBLY

8. [ ] Clean and grease bearings, or replace.

9. [ ] Check axle for bends and replace if necessary.

10. [ ] *If replacing axle,* insert long 5mm Allen from right end of axle and use 14mm cone wrench to break loose outer cap, then unthread inner cap. (If inner cap is secure to axle, there is no choice except to grasp axle in vise to unthread inner cap.)

11. [ ] ***If axle was replaced,*** **thread cap(s) onto new axle.**
12. [ ] **Grease axle thoroughly.**
13. [ ] **Grease inner and outer cylindrical surfaces of both bearings.**
14. [ ] **Grease bearing-mounting surface inside shell.**
15. [ ] **Place wavy washers in each end of shell.**
16. [ ] **Slide bearing and spacing sleeve onto axle.**
17. [ ] **Slide axle assembly into left end of shell.**
18. [ ] **Slide bearing onto right end of axle.**
19. [ ] **Thread right-side cap onto axle.**
20. [ ] **Holding axle with 14mm cone wrench (rear) or 5mm Allen (front), use 5mm Allen wrench to gently secure right-side axle cap.**

WHITE INDUSTRIES TI CASSETTE HUB

This hub is one of several made by White Industries. The other models are simpler (front or rear for thread-on freewheel). By ignoring steps and illustrations that are specific to the freehub mechanism (called "driver" by the manufacturer), the following procedure can be used as a guide to service any White Industries hub.

DISASSEMBLY

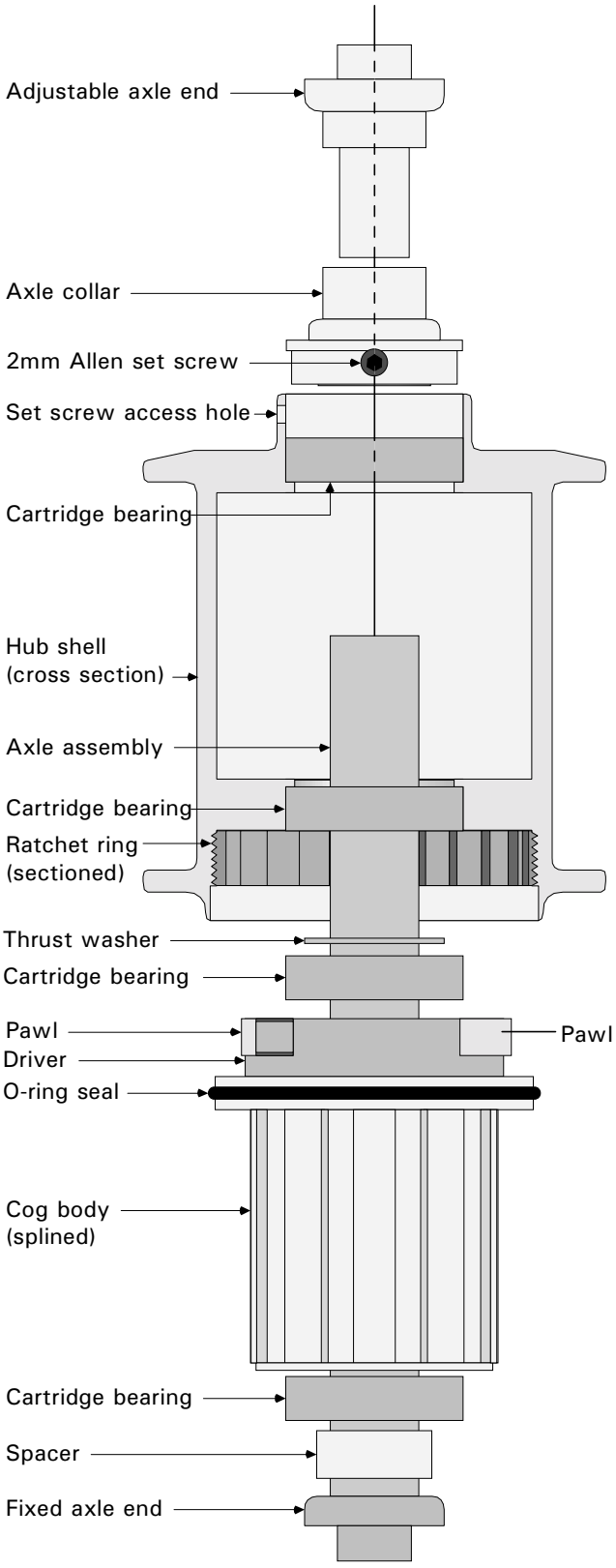
1. [ ] **Remove cogset from hub (same as Shimano freehubs).**

In step #2, three 2mm Allen set screws are loosened. If loosened too little, the parts will still remain together. If loosened too much, the set screws will interfere with the inside of the hub shell, and it will not be possible to rotate the axle collar relative to the hub shell, or to pull it out of the hub shell. Loosen all three 2mm Allen set screws one full turn. This amount should be ideal.

2. [ ] **With 2mm Allen wrench, loosen 3 set screws accessible through hole in lip in left end of hub shell 1 full turn each.**

In the next step, the adjustable axle-end is pulled out of the left end of the axle. It is supposed to pull out easily after loosening the set screws (in the previous step). Corrosion could make axle-end removal difficult. There is a 6 × 1mm thread inside the axle-end piece. If it is difficult to remove the axle-end, thread in a long bolt of the correct thread. Grasp the bolt head firmly in the vise and pull the wheel away from the vise.

3. [ ] **Pull adjustable axle-end out of left axle end.**



13.18 *The White Industries TI Cassette hub.*

The axle collar can be difficult to pull out because one (or all) of the set screws has been loosened too much, or because the axle is corroded. With the left-side down, press the wheel against the bench top to get the axle to move. If this does not work, try inserting a conventional axle inside the White Industries axle, then tap on the conventional axle. The drive-side axle-end is a press fit augmented with Loctite. It may pop out before the axle releases. If this happens, it will need to be tapped back in with fresh Loctite.

4. [ ] **Pull axle collar out of left side of hub shell.**
5. [ ] **Pull axle and driver together out right side of hub shell.**
6. [ ] **Remove thrust washer (which may be stuck to inside face of driver or outside face of bearing in right side of hub shell).**
7. [ ] **Pull driver off of axle.**

CLEANING AND RE-GREASING

8. [ ] **Use seal pick or small pointed device to gently lift seals out of both bearings in hub shell and both bearings in driver.**
9. [ ] **Scrub, flush, and dry all exposed bearings, hub shell, driver assembly, and axle parts.**
10. [ ] **Pack all bearings with grease.**
11. [ ] **Replace seals in bearings with lettered-sides facing out.**

BEARING REPLACEMENT

Hub-shell bearing-cartridge removal

See page 13-22 for up-to-date information on tools for bearing removal and installation.

12. [ ] **Insert lip end of White 15mm bearing remover into left-side bearing, then support left side of hub shell on top end of any race installer that can be used on a 1–1/8" fork.**
13. [ ] **Use small White drift to tap out bearing.**
14. [ ] **Insert lip end of White 15mm bearing remover into right-side bearing, then support right side of hub shell on top end of any race installer that can be used on a 1–1/8" fork.**
15. [ ] **Use small White drift to tap out bearing.**

Driver bearing-cartridge removal

16. [ ] **Insert bearing remover into outer bearing, place any used Shimano freehub cog on driver, then place driver upside-down in vise with cog resting on top of vise and vise jaws *not* clamping on driver.**
17. [ ] **Use small White drift to tap out bearing.**
18. [ ] **Insert bearing remover into inner bearing(s), then support inward end of driver on top end of any race installer that can be used on a 1–1/8" fork.**
19. [ ] **Use small White drift to tap out bearing.**

Installing bearing cartridges in hub shell

20. [ ] **Slide large spacer and right-side hub bearing onto shaft of White Bearing Installer.**
21. [ ] **Put tool shaft into hub shell from right side.**
22. [ ] **Place left-side bearing over end of tool shaft.**
23. [ ] **Put large spacer over tool shaft, then thread on handle/bearing assembly.**
24. [ ] **Place fixed end of tool in soft jaws in vise.**
25. [ ] **Tighten tool handle until both bearings are fully seated.**
26. [ ] **Unthread handle, then remove hub from tool.**

Installing bearing cartridges in driver

27. [ ] **Place large spacer, then small spacer, then outer bearing over tool shaft.**
28. [ ] **Place driver outer-end down over tool shaft, then inner bearing(s), then both spacers, then thread on handle/beraring assembly.**
29. [ ] **Tighten handle until all bearings are seated.**
30. [ ] **Unthread handle, remove driver from tool, and remove tool from vise.**

ASSEMBLY

31. [ ] **Grease outside of axle shaft and grease outside of inserted portion of left-side adjustable axle-end.**
32. [ ] **Use light oil on pawl springs, pawls, and O-ring seal on driver.**
33. [ ] **Slide spacer onto axle, followed by driver and thrust washer.**
34. [ ] **Insert axle/driver assembly into right side of hub shell.**
35. [ ] **Rotate driver counterclockwise while maintaining slight inward pressure to get pawls to seat inside ratchet ring.**
36. [ ] **With right end of axle supported on bench, press down firmly on wheel to make sure everything is seated.**
37. [ ] **Install axle collar on left end of axle.**
38. [ ] **Install adjustable axle-end in left end of axle.**
39. [ ] **Rotate axle or axle collar to align set screws with access hole in lip on left side of hub shell and secure each set screw.**
40. [ ] **Install and secure cogset.**

CHRIS KING FREEHUBS

This section applies specifically to the Chris King MTB, road, and DiscGo-Tech rear hubs. Although not specifically for the BMX hub, once you are familiar with the hubs covered here, the BMX hub should not be a challenge to service.

There are two levels of service possible. The basic service includes cleaning or replacement of drive mechanisms and greasing of bearings. The full service adds to this bearing replacement and drive mechanism parts replacement. The basic service requires one inexpensive special tool, Hub Cone Adjusting Tool #77301. The full service requires a complete Chris King Hub Service Kit (number unavailable). Additionally, a 2–1/4" section of 2–1/4" I.D. PVC pipe and ordinary shop tools are needed.

TOOL TERMINOLOGY

The following tools are all part of the Chris King Hub Service Kit.

Cog spline wrench: A large-diameter ring with splines on the inner perimeter. It is labeled "cog spline wrench."

Cone washer: A steel washer with a conical face on one side.

Driveshell bushing: A long cylinder with a larger diameter at one end. It is labeled "driveshell bushing."

Extension shaft: A threaded shaft with two thread diameters, ending in a knurled shaft at one end.

Hub cone adjusting tool: A medium-length cylinder with four steel pins in a recess in one end. It is labeled "hub cone adjusting tool."

Knurled ring: A ring with several steps of various diameters on each face, with a knurled texture at the outermost perimeter. It is labeled "knurled ring."

Spline driver: A short cylinder with a square hole in one face and a splined configuration in the opposite face. It is labeled "spline driver."

Split rings: Two rings (large and small) split in half and held together by means of an O-ring in the groove in the outer perimeter of the ring. They are labeled "lg split ring" and "sm split ring."

T-handle: A large stepped cylinder with a threaded shaft at one end and a handle inserted through a ball at the other end of the cylinder. It is labeled "T-handle."

PART TERMINOLOGY

Adjusting cone: A ring with four holes in its face that resembles a dust cap that is used to adjust the bearing preload.

Axle end: A cap that threads onto the left end of the axle.

Capture plate: A simple metal washer that keeps the needle-bearing cage from moving out of the needle-bearing race.

Capture sleeve: A metal cylinder with one flat face that keeps the needle bearing cage from moving the other way out of the needle-bearing race.

Drive ring: A ring that has teeth on one face and helical splines on the inner perimeter.

Drive side of hub shell: The side of the hub shell with the larger-diameter hole.

Drive spring: A large-diameter spring that moves the drive ring.

Driven ring: A ring that has teeth on one face and splines on the outer perimeter.

Driveshell: A complexly-shaped cylinder to which the cogs attach. When installed, it resembles a freehub body on a conventional freehub.

Needle bearing: A bearing that is a cylinder instead of a ball.

Needle-bearing cage: A plastic cage of cylindrical shape that holds the needle bearings.

Needle-bearing race: A steel bearing surface in the shape of a simple cylinder on which the needle bearings roll.

Non-drive side of hub shell: The side of the hub shell with the smaller-diameter hole.

Plastic seal (small and large): A thin washer-like seal made of plastic that resembles a shim washer.

RingDrive: The Chris King name for the freewheeling design that is used in these hubs instead of a conventional pawl and ratchet-ring design.

Seal ring: A ring that is threaded on the outside, splined on the inside, and has a blue rubber seal installed in one face.

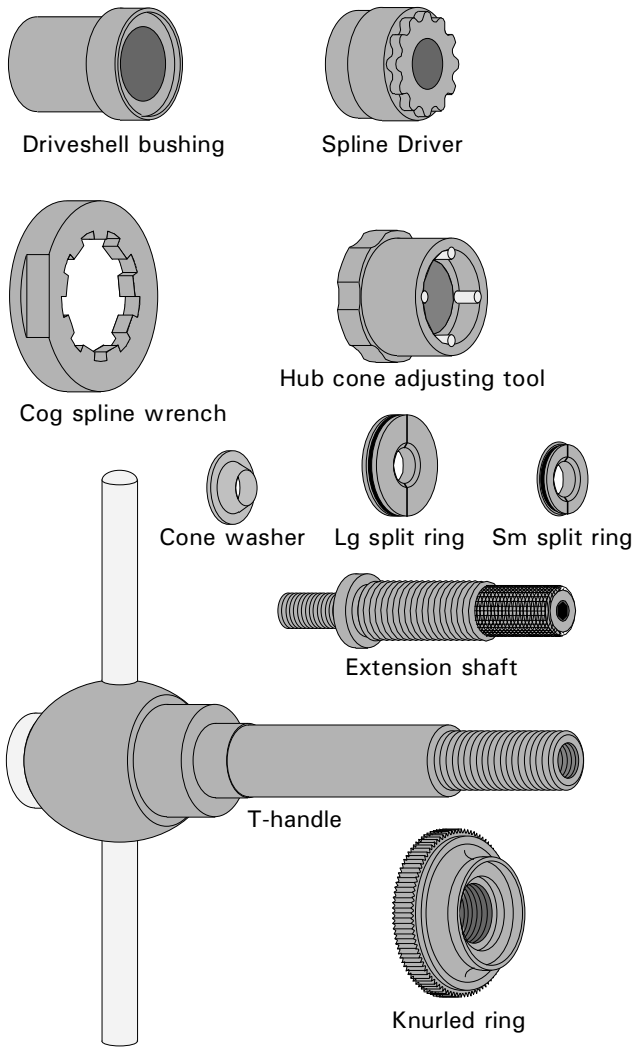
Spring retainer: A flat metal ring that has a slight taper to one face and a clear step-down in diameter on the other face that supports the drive spring.

FULL HUB SERVICE

Axle and bearing-seal removal

1. [ ] **Remove cogs.**
2. [ ] **Insert a 5mm Allen wrench in each end of axle, then unthread left-side axle-end/adjusting-cone assembly.**
3. [ ] **Pull driveshell and axle out drive side of hub with firm counterclockwise twisting motion.**

NOTE: Skip to step 7 if replacing bearings.



13.19 The Chris King hub tool set.

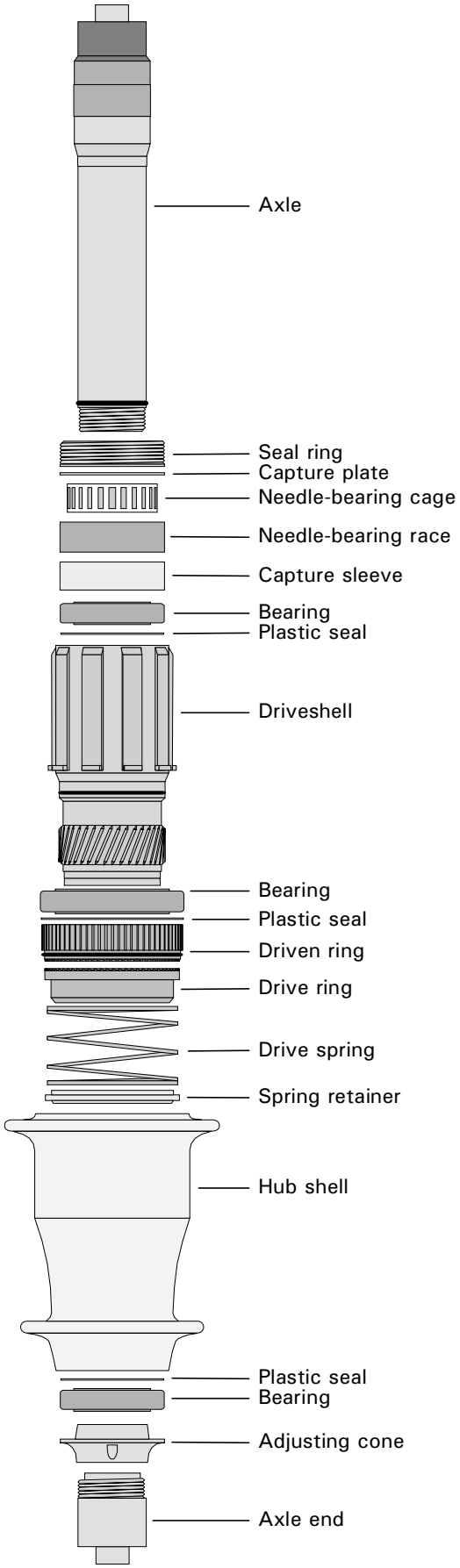
4. **[ ] Insert tip of razor knife in diagonal split of metal snap ring in face of drive-side hub-shell bearing to lift one end of ring, then pull snap ring out of bearing. Repeat on non-drive side.**
5. **[ ] Use seal pick to lift soft rubber seal out of face of each bearing.**

Chris King recommends use of a light spray lubricant instead of solvent when cleaning parts and bearings to avoid any possibility of damaging plastic and rubber parts with solvent.

6. **[ ] Flush exposed bearings with light spray lubricant and dry with compressed air. Use light lubricant on brush to carefully clean helical splines on driveshell and inside drive end of hub shell.**

In the next step, removing the O-ring makes it easier to pull the axle out, but it is not necessary. If you remove it, take care not to lose it and to remember to replace it.

7. **[ ] Remove small O-ring from non-drive end of axle, then push axle out large end of driveshell.**



13.20 The Chris King cassette hub.

NOTE: Skip to step 35 if not replacing bearings.

Non-drive side bearing removal

In the next step, the split ring, extension shaft, and cone washer are assembled to the T-handle. If the extension shaft is threaded in too much, the split ring is expanded and will not pass through the bearing. The small split ring is not symmetrical, so observe which face of the ring is a larger diameter.

8. [ ] **Place small split ring (large-diameter-face first) on small end of extension shaft, place cone washer (cone-side first) against split ring, then thread extension shaft fully into end of T-handle without expanding split ring.**
9. [ ] **Insert T-handle through drive side of hub.**

The knurled ring is a complexly-shaped tool with several steps or shoulders of various diameters on each of its faces. The purpose of the configuration is to insure, if properly oriented, that the knurled ring acts somewhat like a pilot to align the bearing and the T-handle. Another function of the knurled ring, achieved by threading it on the recommended amount, is to set the depth of the split ring so that when the split ring is expanded it is in the correct position relative to the bearing. If the wrong end of the knurled ring is threaded on first, then the number of turns will not work to correctly position the split ring.

10. [ ] **Thread knurled ring, big-end first, fully onto extension shaft, then back off exactly seven full turns.**

A sure sign in the next step that the knurled ring has been threaded on the wrong amount is that the T-handle gets tight in a fraction of a turn when tightening it to expand the split ring. If this happens, loosen the T-handle and unthread the knurled ring about one turn, then try again.

11. [ ] **Pull tool assembly out drive side of hub until knurled ring seats against hub, then hold extension shaft stationary and turn T-handle clockwise until split ring is fully expanded.**
12. [ ] **Turn knurled ring fully clockwise.**
13. [ ] **Tap on T-handle tool with plastic mallet to drive bearing out non-drive side of hub.**
14. [ ] **Unthread knurled ring, then remove in order non-drive-side bearing and small plastic seal.**
15. [ ] **Unthread extension shaft and remove tools from hub.**

Drive-side bearing removal

16. [ ] **Place large split ring on small end of extension shaft, place cone washer (cone-side first) against split ring, then thread extension shaft fully into end of T-handle without expanding split ring.**
17. [ ] **Insert T-handle into non-drive side of hub.**
18. [ ] **Thread knurled ring (big-end first) onto extension shaft exactly three full turns.**
19. [ ] **Pull tool assembly out non-drive side of hub until knurled ring seats against hub, then hold extension shaft stationary and turn T-handle clockwise until split ring is fully expanded.**
20. [ ] **Turn knurled ring fully clockwise.**

In the next two steps, as the bearing is pressed out there are a number of other parts that will come out at the same time. The set up of the tool is designed to insure that all the parts come out together, trapped on the tool in the order they are installed in the hub shell. By following the directions closely, it is possible to then take these numerous parts off the tool in order, so as to become familiar with the sequence and orientations of the parts.

21. [ ] **With drive side of hub supported on PVC pipe, tap on T-handle tool with plastic mallet to drive bearing out drive side of hub.**
22. [ ] **Unthread knurled ring, then remove in order drive-side bearing, large plastic seal, driven ring (externally splined), drive ring (internally splined), drive spring, and spring retainer.**
23. [ ] **Unthread extension shaft and remove tools from hub.**

Driveshell disassembly

In the next step, the driveshell is inserted in the cog spline wrench, and both are grasped in the vise. There is no need for high force when closing the vise, and the tools and parts could easily be damaged by excess force. Consider the side of the tool with writing to be the front face, and the blank side to be the back face.

24. [ ] **Insert driveshell into back face of cog spline wrench, then gently secure flats of wrench in vise.**
25. [ ] **Place spline driver on 3/8" drive wrench, then use spline driver to unthread seal ring from driveshell.**
26. [ ] **Remove capture plate then needle-bearing cage from driveshell with your fingers (needle-bearing race and capture sleeve remain in driveshell).**

The previous step says that the needle-bearing race and capture sleeve remain in the driveshell. In some cases, in the next step they may be loose and prone to falling out without encouragement. If this is the case, it is fine to let them come out at this time.

27. [ ] **Remove cog spline wrench from vise, remove driveshell from cog spline wrench, then reinsert driveshell into front face of cog spline wrench.**

28. [ ] Place small split ring (large-diameter-end first) on small end of extension shaft, place cone washer (cone-side first) against split ring, then thread extension shaft fully into end of T-handle without expanding split ring.
29. [ ] Insert T-handle through small end of driveshell.
30. [ ] Thread knurled ring (small-end first) onto extension shaft exactly 2–1/2 turns, then pull tool through drive shell until large shoulder on face of knurled ring seats inside end of driveshell.
31. [ ] Holding extension shaft stationary, turn T-handle clockwise until split ring is fully expanded, then turn knurled ring fully clockwise.
32. [ ] Grasp flats of cog spline wrench in vise, then tap on T-handle with plastic mallet to drive bearing parts out bottom of driveshell.
33. [ ] Remove cog spline wrench from vise, unthread knurled ring from extension shaft, then remove in order needle-bearing race, capture sleeve, bearing, and small plastic seal.
34. [ ] Unthread extension shaft and remove all tools from driveshell.

Bearing and RingDrive lubrication

Chris King makes special grease for use in the Chris King hubs. Although deviation from the recommended grease may not be as critical inside the ball bearings, the wrong lubricant can make the RingDrive non-functional. The recommended grease is very light, and in its absence Chris King recommends a high-quality 10W oil, never another grease! When greasing the bearings, it is critical to use a moderate amount. Too much grease will make it impossible to seat the rubber seal and snap ring.

NOTE: Skip to step 39 if replacing bearings.

35. [ ] Place small bead of Chris King grease one-half to two-thirds of way around inside of hub-shell bearings.
36. [ ] Place rubber seals over grease and carefully seat between inner and outer races.
37. [ ] Engage one end of split ring in groove between inner and outer races, then work all the way around, seating split ring into bearing. Repeat for other bearing.
38. [ ] Use finger to separate drive rings and put bead of Chris King grease in gap between drive rings. Release ring, then smear excess grease over helical splines.

NOTE: Skip to step 56 if not replacing bearings.

Non-drive-side bearing installation

All three of the bearing cartridges are non-symmetrical. Upon examining the hole in each of the three bearing cartridges, it can be seen that one end of the hole is tapered inside. When each bearing is installed, be sure to note which way this "internally-tapered end" should face. Failure to orient the bearings correctly will make it impossible to complete the hub assembly, and also makes it extremely difficult to remove the bearing without damaging the plastic seal that sits behind each bearing. In all three cases, the correct bearing orientation is such that the tapered end of the hole ends up facing out from the center of the hub.

39. [ ] Holding T-handle threaded-end up, place small bearing (internally-tapered end first) onto T-handle, then place small plastic seal on top of bearing.

In the following bearing installation, as well as all the other bearing installations, the correct orientation of the knurled ring is critical in two respects. First, the knurled ring must face the correct way so that the intended surface on the hub shell or driveshell supports the high load of pressing in the bearings and so that the knurled ring serves its purpose of aligning everything. Second, the knurled ring needs to be correctly seated against the supporting surface. If these cautions are not observed, the supporting surface and the bearing counterbore can easily be damaged while pressing the bearings.

40. [ ] With T-handle tool held threaded-end up, place hub shell (non-drive-side first) over tool, then thread knurled ring (large-end first) onto T-handle.

By Chris King's recommendation, a seemingly redundant process is used when seating each bearing. The company's position is that this process insures proper bearing alignment. This is why the next step includes tightening the T-handle twice.

41. [ ] Tighten T-handle until bearing seats fully, loosen T-handle, rotate knurled ring 180° either way, then secure T-handle again. Remove tools.

Drive-side bearing and RingDrive installation

42. [ ] Check that O-ring is in place inside inner perimeter of spring retainer, then install spring retainer in drive side of hub so that stepped face faces out drive side of hub.
43. [ ] Insert drive spring in drive side of hub.
44. [ ] Use Chris King grease to lubricate toothed face and helical spline of drive ring (internally splined), then insert ring so teeth face out drive side of hub.
45. [ ] Insert driven ring (externally splined) tooth-face first into hub so splines engage hub shell splines.
46. [ ] Place large plastic seal over driven ring, then insert large bearing so internally-tapered end

faces out of hub.

47. [ ] Insert T-handle through non-drive side of hub, then thread knurled ring (large-end first) onto T-handle and against face of bearing.

48. [ ] Tighten T-handle until bearing seats fully, loosen T-handle, rotate knurled ring 180° either way, then secure T-handle again. Remove tools.

Driveshell assembly

49. [ ] Holding T-handle threaded-end up, place onto threaded end in order driveshell bushing (small-end first), small bearing (internally-tapered end first), small plastic seal, and driveshell (large-end first).

50. [ ] Thread on knurled ring (large-end first) until it seats over end of driveshell.

51. [ ] Tighten T-handle until bearing seats fully, loosen T-handle, rotate knurled ring 180° either way, then secure T-handle again. Remove tools.

If the needle-bearing race did not fall out while disassembling the driveshell assembly, then the following step will be needed in full to install the capture sleeve and needle-bearing race. If they did fall out during disassembly, the two parts should simply slip into place during the next step, and then it will be unnecessary to use the seal ring as an installation press for these parts.

52. [ ] Place capture sleeve (flat face facing out) and needle-bearing race into large end of driveshell. If necessary, use spline driver and seal ring to seat needle-bearing race fully, then remove seal ring.

53. [ ] Insert driveshell into back face of cog spline wrench, then gently secure cog spline wrench in vise.

54. [ ] Grease needle-bearing cage with Chris King grease, then insert needle-bearing cage and capture plate into driveshell.

55. [ ] Thread seal ring into driveshell, then secure to 100in-lbs. Remove driveshell from tools.

Axle assembly and adjustment

56. [ ] Insert axle into large end of driveshell until it seats with a "pop," then put small O-ring back onto threaded end of axle.

57. [ ] Insert axle/driveshell assembly into drive side of hub with a clockwise rotation and a forceful push, until it seats with a "pop."

58. [ ] Put 5mm Allen wrench in vise, end pointing up, then place right end of axle onto Allen wrench.

59. [ ] Thread adjusting cone fully onto axle end, then thread assembly onto left end of axle (do not secure).

Like all other hubs that utilize quick-release retention, the axle of a Chris King hub compresses when the wheel is installed in the dropouts and the quick release is properly secured. Unlike conventional hubs, it is not possible to simulate this compressive load at the same time as making the adjustment, so it is necessary to use a trial and error process of adjustment, starting with an adjustment that is clearly too loose, then making fine adjustments until the looseness just disappears once the wheel is correctly installed in the bike.

60. [ ] Holding axle end stationary, rotate adjusting cone clockwise until contact is felt, then counterclockwise 1/4 turn. Stabilize adjusting cone while gently securing axle end.

61. [ ] Place wheel in frame and correctly secure quick release, then check for knock by jerking laterally on rim. (If no knock is felt the first time this step is attempted, redo step 60 with a slightly looser starting adjustment.)

62. [ ] If knock is felt, remove wheel and put right end of axle back on Allen wrench in vise.

63. [ ] While stabilizing adjusting cone, loosen axle end, then turn adjusting cone a few degrees clockwise and secure axle end. Repeat check in step 61, and stop if knock is eliminated.

CARTRIDGE-BEARING TOOLS

There are several tools recently available or currently available that are in the category of "universal" cartridge bearing removers and installers.

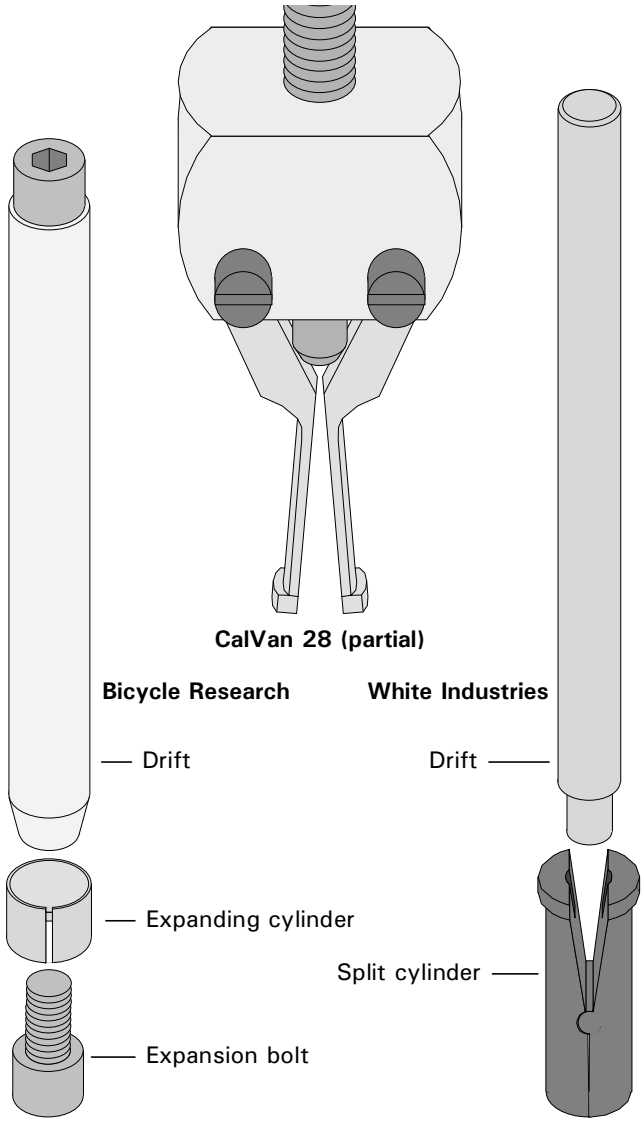
Due to the variety of hub designs, no tool can be truly universal, but with a good assortment of tools and a little ingenuity, virtually any hub can be serviced.

REMOVAL TOOLS

There are three choices of removal tools. These are the Bicycle Research Sealed Bearing Remover Kit (#SBR-K), the White Industries Bearing Extractors, and the CalVan #28.

The Bicycle Research SBR-K is the most universal tool. It works on the principle of an expanding cylinder that grips the inside bore of the bearing by means of friction. This design eliminates the need for access to the back face of the bearing, which is not always accessible. This tool kit includes five sizes of removers: 10mm, 12mm, 1/2", 15mm, and 17mm. The limitation of the tool is that bearings that have a large I.D./O.D. difference, are heavily secured with Loctite, or are corroded in place may have more friction holding

them in place then the tool can generate between the tool and the bearing. If this is the case, the tool will keep slipping out before the bearing is moved.



13.21 *Bearing removal tools.*

Proper care and use of the SBR-K is important. The expanding cylinders are easily destroyed if they are expanded when not contained by a bearing they are designed to fit, so never tighten the bolts unless the expanding cylinder is inside a bearing that it is intended to fit. With the expansion cylinder inside the bearing, simply tighten the bolts at each end of the tool to the typical limit of the Allen wrench, then tap on the end of the tool to drive the bearing out. Using a high-strength, zero-residue solvent such as acetone or alcohol on the mating surfaces of the tool and bearing will increase the maximum friction and effectiveness of the tool. Once removal has been accomplished, it can be somewhat awkward to remove the bearing from the tool. This problem can be reduced by greasing the inside of the expansion cylinders.

White Industries sells tools that work on the principal of a lip that catches on the back side of the bearing. The early version of their tool consisted of three sizes of these split cylinders with lips (12mm, 15mm and 17mm). To use the tool, the lip-end of the remover was compressed in order for the lip to be able to pass through the bearing, then held in an expanded state by means of a special shaft that was used both to hold the split cylinder open and to drive against the cylinder in order to press out the bearing. The current version is much less expensive, but not nearly as strong. It, too, uses a split cylinder with lips that catch the bearing, but relies on a screwdriver as the means to spread the cylinder and drive against the cylinder. The advantage of these lip-type tools is that they never slip out. The disadvantage is that if there is not adequate clearance on the back side of the bearing, the tool will not fit.

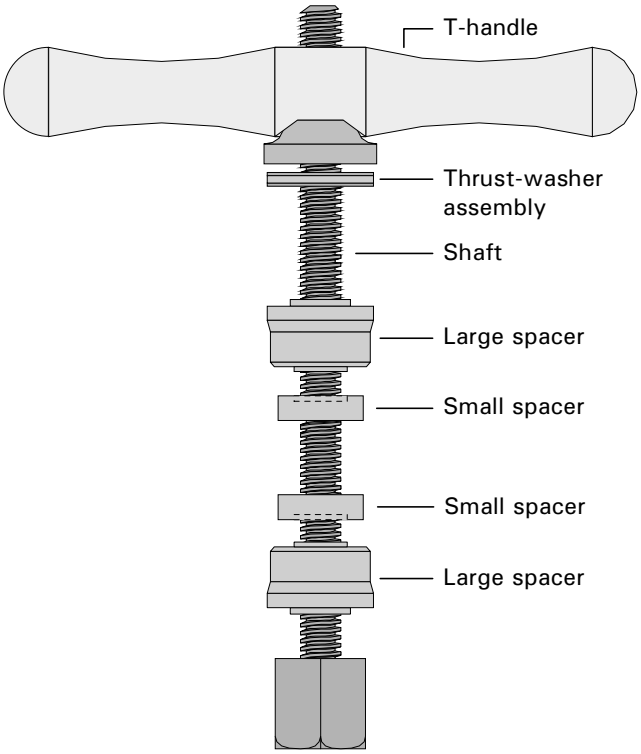
The CalVan #28 is a single tool with lipped prongs that spread apart as the tool handle is tightened. The lips are somewhat thinner than the White Industries tool, so the CalVan #28 will fit some bearings that the White Industries tool will not. Since it is not size specific like the other removers, it is more universal. However, the fit is not precise and the tool is much more awkward to use.

For the complex area of bearing removal, the well-equipped mechanic would want each of these tools.

INSTALLATION TOOLS

There are two varieties of universal bearing installers. These are the Bicycle Research Sealed Bearing Installation Kit (#SBI-K) and the White Industries Bearing Press (#Bearing-PR). Both work on the principle that various diameters of spacers mate against the face of the bearing, with a threaded shaft that inserts through the bearings and spacers to draw the whole assembly together when tightened. The difference between the tools is primarily in the number and configuration of spacers.

The White Industries tool has spacers that match the bearing O.D. of 24mm, 28mm and 30mm, and some of these spacers have lips that fit in 15mm and 17mm holes. The shaft itself fits a bearing with a 12mm I.D.



13.22 *White Industries bearing-installation tool.*

The Bicycle Research tool has spacers that match the O.D. of 24mm, 26mm, 28mm, 30mm, 32mm and 35mm bearings. Additional spacers match the bearing I.D. of 12mm, 15mm and 17mm. The shaft itself fits a bearing with a 10mm I.D.

Despite these differences in spacers and shaft diameters, both tools will fit all the popular hub designs. The I.D. spacers on the Bicycle Research tool tend to get lost in the hub unless the entire installation process is done with the tool precisely horizontal. The White Industries tool has an edge in ease of use because its I.D. spacers cannot slip out of position.